(2) (JOISS)

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Contents

Chapter 1

intro

Chapter 2

CTD(SBE 911plus)

2.1

SBE 911plus CTD Sea-Bird Electronics , WOCE(World Ocean Circulation Experiments) (Kim et al,2000). SBE 9plus underwater unit (main housing, pump and sensors) CTD , , SBE 11 deck unit . , deck unit water sampler button , . 24 . SBE 9plus 1 1 .

SBE 5T SBE 5P (30 /s) 0.4 T-C duct . CTD . T-C duct duct 0.073 conductivity cell . (0.073) , SBE 11plus Deck Unit .

2.2

2.2.1

2.2.1.1

(resistance) , thermistor (, signal) . , / / , / thermistor / . time constant(step change , 63%) 70ms(0.070) . SBE9plus underwater unit 24Hz, 0.0417 . Sea bird . Data processing Alignctd .

2.2.1.2

2 cm3 , 30 /s 67ms . time constant 24ms(0.024s) .

. , , . . SBE11plus deck unit 0.073 , primary +1.75scans(24Hz 1.75/24=0.073 seconds) factory-set , thermocline (-0.08 ~0.08) . . alignctd .

2.2.1.3

(piezoresistive effect) . . 50 . , . SBE 9plus Paroscientific Digiquartz . , .

2.2.1.4

SBE 43 membrane , electrode Teflon membrane electrode electrolyte . electrode , . 20℃ time constant( ) 2 , sensor membrane age .

2.2.2

SBE 9plus SBE 32 Carousel Water Sampler . (horizontal mount) (vertical mount) , .

2.2.2.1 vertical mount

13 mm, 19 mm Tygon (Tygon tubing) . . . DO 13 mm 9.5 mm Tygon tubing Tygon tubing(13 mm) . DO conductivity cell Y-fitting .

2.2.2.2 horizontal mount

13 mm, 19 mm Tygon tubing . DO conductivity . DO . . DO 13 mm 9.5 mm Tygon tubing Tygon tubing(13 mm) . DO conductivity cell .

2.2.3

2.2.3.1 bottom end cap

SBE 9plus bottom end cap pressure port connector 6 (4). pressure port primary temperature primary conductivity connecto(JB1, JB2), connector(JB3), secondary temperature secondary conductivity connector(JB4, JB5) , SBE bottom contact switch connector(JB6) . temperature conductivity pin 3 (3-pin) , 3-pin cable(; 17086, 6) bottom end cap connector(JB1, JB2, JB4, JB5) . JB3 2-pin cable(; 17133, 7) , 2 Y-cable(; 17799, 8) .

2.2.3.2 top end cap

SBE 9plus top end cap 2-pin connector(JT1), 3-pin connector(JT4) 5 6-pin connector(JT2. JT3, JT5, JT6, JT7) (5). 2-pin connector sea cable(; 17027, 17028, 17136 , 9) cable JT2, JT3, JT5, JT6 connector . DO (SBE43) 6-pin-4-pin cable(; 171491, 10) . SBE32 Carousel water sampler JT7 connector 6-pin-6-pin cable(; 17198, 11) , General Oceanics Rosette water sampler JT4 3-pin-3-pin cable(; 17196, 17533 , normal polarity, reverse polarity) . ※ SBE 9plus 2-pin connector 3 (JT1, JB3, JB6) JT1 sea cable JB6 CTD 2007 2 SBE 9plus JB6 (female) . JB3 sea cable JT1 (male) 2-pin connector .

2.3

2.3.1 SEASAVE

seasave CTD , GPS , CTD , display . seasave setup program setup file (*.psa) (12).

2.3.1.1 (Instrument Configuration) : seasave > configure inputs

configuration file , post-calibration .

seasave , configuration inputs Instrument configuration (3-1), (Open) (Create) (*.con), 'Modify' . 'Create' , '911/917plus CTD' , "Frequency channels suppressed" 0,1,2 (3-2). Frequency . T, C single/dual , dual T, C 0 , dual T & single C 1 , single T, C 2 . T, C frequency (voltage) T, C . "Voltage words suppressed" 0~4 (3-2), CTD underwater unit (DO, fluorometer, altimeter, nitrate sensor, turbidity-meter) .

JT2(V0, V1), JT3(V2, V3), JT5(V4, V5), JT6(V6, V7) 8 (2 Voltage .
voltage) (3-3), voltage Voltage words suppressed . , JT6 altimeter V6 , 0 Voltage 7 . 0 voltage 7 , 1 voltage 5 , 2 voltage 3 , 3 voltage 1 , 4 . 4 .

“Computer interface” IEEE-448 RS-232 . Deck unit computer RS-232 .

“Scans to average” . CTD full data 1 , 24Hz SBE911 CTD 24 , 1 1 .

“Surface PAR voltage added” underwater unit PAR Surface PAR . Application Note 11s .

“NMEA position data added” NMEA , NMEA . Pressure (m) , configuration inputs ”Miscellaneous” .

“Scan time added” data scan (GMT 1970 1 1) . . , Free calibration sheet . , . 3-1 voltage .

, Save save as . ( ) .

2.3.1.2 ’Serial Ports’

. Deck unit computer 3-6 deck unit (4) SBE11 interface (RS-232) (7) MODEM CHANNEL(water sampler) Deck unit (3-7) 1 . 9pin 2~3 USB , 9pin USB USB . deck unit (3) . CTD Deck unit underwater unit (8) , NMEA (10) .

, port (3-8). “CTD Serial port” deck unit (4) com port , Baud rate(9600 19200), data bits (8), parity (None) . “Water sampling port” deck unit (7) com port . “Serial Data Output data port” “Output data to serial port” . “SBE14 Remote display Serial Port” “Send data to SBE14 remote display” .

water sampler . “Water sampler type” SBE carosel , “Number of Water Bottles” Niskin bottle Carosel water sampler trigger part (3-10) Bottle trigger . , bottle 6 , trigger 12 12 . “Firing sequence” sequential/User input , Sequential bottle firing , User input firing . “Enable remote firing” TCP/IP port computer firing . .

Seasave window display (depth, average sound velocity, descent rate, acceleration, oxygen, plume anomaly, and potential temperature anomaly) , . “Latitude when NMEA is not available” NMEA navigation Seasave pressure depth depth . NMEA .

‘OK’ configuration file .

2.3.1.3 Water Sampler

Configure Inputs Water Sampler (20). Water sampler type SBE Carousel . Number of Water Bottles carousel bottle (24 carousel 20 bottle 24). Firing sequence User Input (Sequential firing bottle firing)

2.3.1.4

Configure Outputs SBE11plus Alarms (21). altimeter Enable altimeter alarm . Alarm set point(meters) altimeter .

2.3.1.5 (Display)

Window display sea-save . 4-1 Fixed, Scrolled, Plot display , . 24Hz 8Hz ( ) . , 1 , 1 display , 0 .

2.4 4.

46
4.5. CELLTM

$Conductivity = (g + hf^2 + if^3 + jf^4)/[10(1 + \delta t + \varepsilon p)]$ $Siemens/meter$

Chapter 3

( )

3.1

1.1 Guildline Autosal 8400B laboratory salinometer, Seabird SBE 4C , YSI/Hydrolab multiprobe sensor , , .

3.2

2.1 . Cox (1967) , , 100 135 . (1) (2) . (2) (3) .

$S(‰) = 0.03 + 1.8050\ Cl(‰)\ -------------\ (1)$
$S(‰) = 1.80655\ Cl(‰)\ ----------------\ (2)$
$S(‰) = -0.08996 + 28.29720\ R_{15} + 12.80832\ R_{15}^2$
$-10.67869\ R_{15}^3 + 5.98624 R_{15}^4 - 1.32311 R_{15}^5\ ---\ (3)$

International Association for Physical Sciences of the Ocean(IAPSO) (chlorinity) (Batch P31, chlorinity 19.375, S(‰)=35.002) . 1978 new salinity scale Practical Salinity Scale (PSS78) . Practical Salinity Scale (S_p,Practical salinty) 1kg KCl 32.4356g KCl 15℃, (K_{15}) (4) . KCl 1kg KCl 32.4356 g 15℃, 35 ‰ 1.0000 KCl . IPTS68 (t68 = 15℃) , 1983 ITS-90 . 1983 1983 (T_{68}=1.00024T_{90}, Saunders, 1990).

$S_p = 0.0080 - 0.1692\ K_{15}^{\frac{1}{2}} + 25.3851\ K_{15} + 14.0941\ K_{15}^{\frac{3}{2}}$
$- 7.0261\ K_{15}^{2} + 2.7801\ K_{15}^{\frac{5}{2}}\ ----------\ (4)$

(T) (RT) (4) (5) SBE 4C, YSI, Hydrolab 15 ℃ (RT) .

$S_p(‰) = 0.0080 - 0.1692\ R_T^{\frac{1}{2}} + 25.3851\ R_T + 14.0941\ R_T^{\frac{3}{2}} - 7.0261\ R_T^{2} + 2.7801\ R_T^{\frac{5}{2}}$
$+ \frac{(T-15)}{1+k(T-15)}(0.0005 - 0.0056\ R_T^{\frac{1}{2}} - 0.0066 R_T - 0.0375 R_T^{\frac{3}{2}} + 0.0636 R_T^{2} - 0.0144 R_T^{\frac{5}{2}})\ -----\ (5)$

k=0.0162 . T: salinometer

3.3

3.1 IAPSO ,

3.2 , , , , ,

3.4

T-S bridge, CTD, Salinometer . T-S bridge CTD . CTD . (Salinometer) . Guildline Autosal8400B .

3.4.1 (Bentch top Salinometer)

Guildline Autosal 8400B . WOCE . .

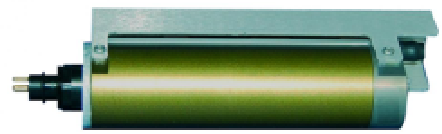
3.4.2 T-S bridge

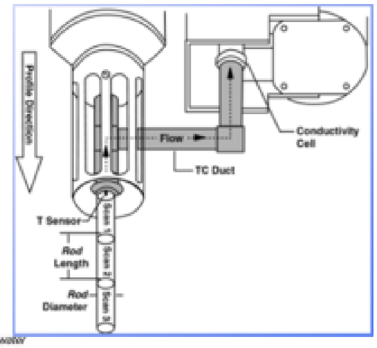
. 5500 salinity bridge 2-40 mmho/cm . T-S bridge . .

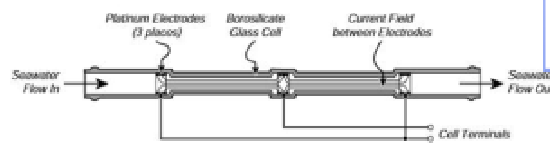
Figure 3.1: Guildline Autosal 8400B

3.4.3 Seabird conductivity sensor (SBE 4C)

SBE 4C 30 cm^3/s 0.4 cm T-C duct duct 0.73 . 0.73 . SBE







9plus data loger .

3.4.4 YSI, Hydrolab etc. multiprobe sensor

YSI multiprobe Hydrolab multiprobe .
, .
.

4.5 , , .

3.5 , , ,

T-S bridge, CTD . , , , .

3.5.1

(flint glass) , poly-seal screw cap . (borosilicate glass)** . 125-250 ml . 0.001 6 (Stalcup,1991). 2 (3) 8 (10) . *Pb $K\text{-}SiO_2$, , , ** (Br)-SiO_2 , , , . Pyrex, Boroil, Simax, Bomex .

3.5.2

4 1 10 . 3 . . / .

3.5.3

. (Muller, 1999). 15-20 ℃ 10 (, 2013).
.

3.5.4

. . cruise identification, station, cast number, water sampler number, storage case identification, salinity sample bottle number .

3.6

6.1 Autosal 8400B Autosal .
6.2 Seabird 4C
Autosal 8400B . , .
. .
(1) . , , , .
6.3 YSI, Hydrolab multiparameter conductivity sensor .
SBE 4C . .
(=3%/℃). , .(20.2 mS/cm at 14 ℃). Specific Conductance 25 ℃ (=1.91%=0.0191). . - (: 1.0 mS/cm, : 10 mS/cm, : 50 mS/cm). -
. - . -
Low-End Specific Conductance Check (5 S/cm),
1 . Low-End Specific Conductance Check
. - 500 1000 S/cm Mid-Range Specific Conductance Check Mid-Range conductivity solution
. Mid-Range Specific Conductance Check
10% .

3.7 Autosal 8400B

3.7.1

AUTOSAL AUTOSAL (standard seawater)
(conductivity ratio) .

3.7.2

(1) : 230V AC 115V AC
(2)Bath : 16.8
(3) : 2

Full Calibration Log Sheet

Sonde ID: _______ Date: _____________ Time: ________ Calibrator's Initials: _______

Battery Check (V): __________ Field User's Initials (if different from Calibrator): _______

Temperature (°C): ______________ ***Temperature must be recorded for all Calibrations (even single probe calibrations)!***

Specific Conductance Probe Calibration

Routine Maintenance Checklist:

1. ***For best accuracy, Specific Conductivity should be calibrated according to the expectations of the streams/sites you will be sampling. It may be necessary to recalibrate between streams/sites due to extreme differences between streams/sites (e.g., 1000 vs. 10000 μmhos/cm). Was Specific Conductance calibrated accordingly?*** **☐ Yes or ☐ No**

2. ***Be sure to check the age of the Specific Conductivity probe. It should be no more than 3 years old. Is it too old?*** **☐ Yes or ☐ No**

Conductivity Solution (μmhos/cm): ____________

Initial Sp Cond (μmhos/cm): __________ Final Sp Cond (μmhos/cm): __________

Low-End Sp Cond Check (i.e., <5 μmhos/cm)
Solution: ☐ Deionized or ☐ Distilled Water Sp Cond (μmhos/cm): ____________

Monthly Mid-Range Sp Cond Check (e.g., 500 or 1000 μmhos/cm)
Conductivity Solution (μmhos/cm): ____________ Sp Cond (μmhos/cm): ____________

Figure 3.2:

(4) : 0.005 42 psu (Conductivity=7.6 S/m Rt=1.15)
(5) : ±0.002 psu
(6) : ±0.0002 psu
(7)Bath :
- setting temp : 18℃, 21℃, 24℃, 27℃, 30℃, 33℃ - : ±0.02 ℃ - : ±0.001 ℃/day (8)Scale Suppression : 0 2.2 Conductivity ratio (22)

Figure 3.3: UTOSAL(8400B)

Figure 3.4: computer interface

3.7.3

, , , , , , , ( )

Figure 3.5:

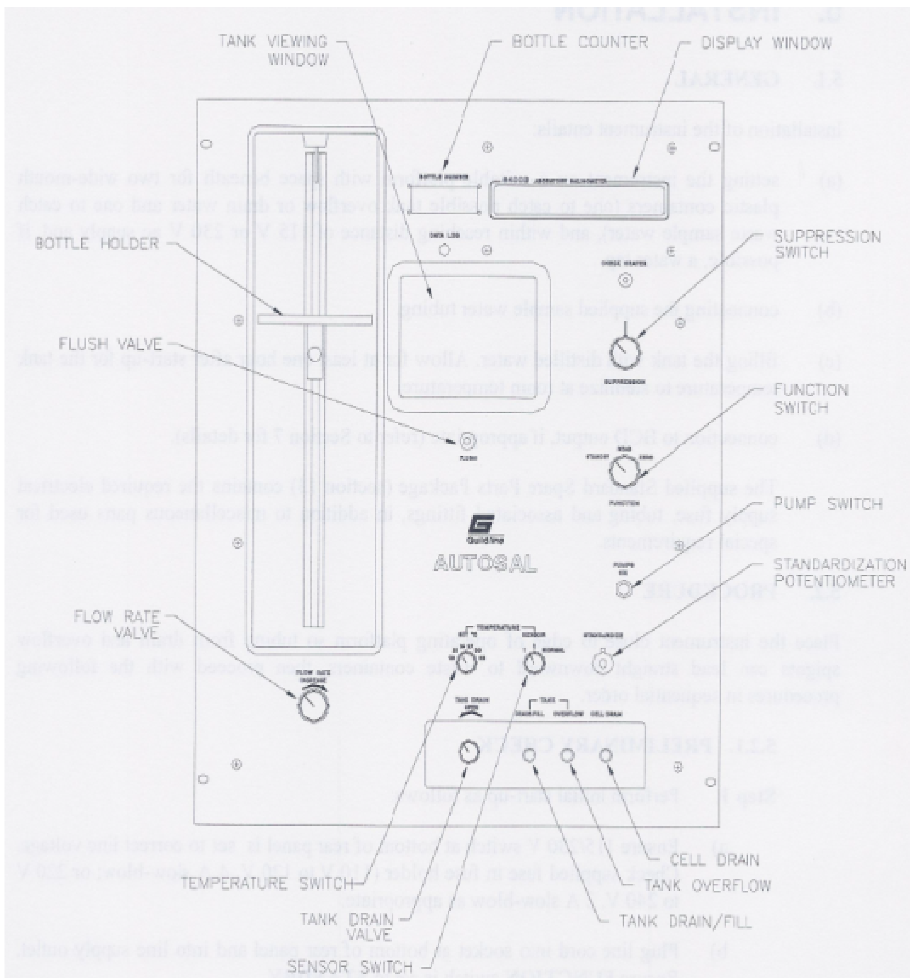


Figure 3.6: Autosal Front Panel

3.7.4 Autosal

(1) .
(2) switch valve .
- suppression switch : ( )
- function switch : standby
- pump switch : off
- flow rate valve : ( )
- temperature set switch : setting
- temperature sensor switch : normal
- tank drain valve :
(3)tank drain/fill, tank overflow : ( )
(4) .
(5)cell drain . cell drain
.
(6) , , , Autosal .
(7) .

3.7.5 Autosal

AUTOSAL 8 . (1) AC
- . - Autosal computer interface . - . - AUTOSAL (AUTOSAL). - FUSE(250V / 2A) . - . (2)temperature bath
- ( ) .
- . .
- bath . bath −2℃ +4℃ . (3)temperature sensor
- temperature sensor switch normal temperature set switch 33 (heater lamp on-).
- temperature sensor switch normal temperature set switch 18 (heater lamp off-).
(4)temperature sensor check
- bath 1 , heater lamp .
- temperature sensor switch normal 1 4 5 heater lamp . - temperature sensor switch 1 2 4 5 heater lamp .
- temperature sensor switch normal .
- heater lamp heater lamp (heater lamp).

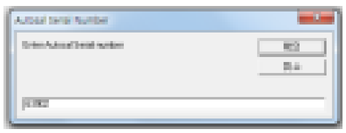
3.7.6

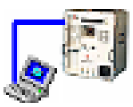
(1)function switch, standby
temperature set switch 24℃
(2)function switch, read
suppression switch 1.9
suppression switch 2.0

computer interface – .

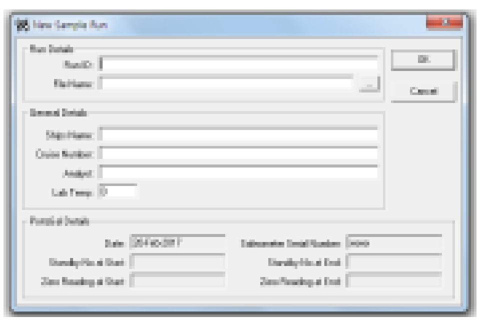
3.7.7 Autosal (warming-up)

, Autosal on , off , Bottle Number, zero
(1) Salinometer Data Logger
(2)File → New. Serial Number

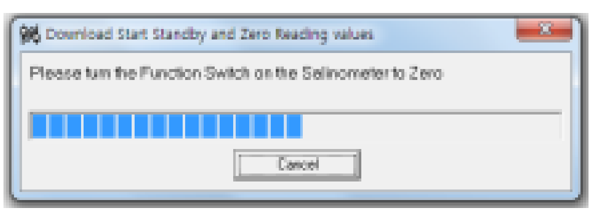




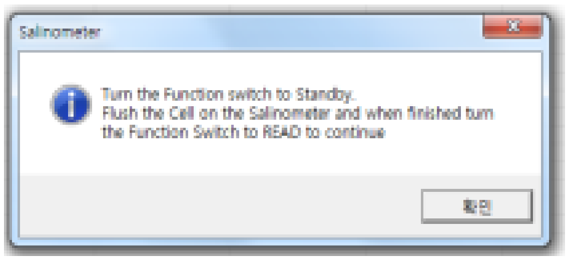
(3) Run ID File Name OK



(4) Autosal Function Switch Zero . 0.0+000x : x=±5 ,
.



(5)Autosal Function Switch Standby .



(6) 6 .
- .
- Autosal Pump Switch 3 Flushing Pump Switch .
- Pump(flow rate : 1) Switch Pump Switch .
- 6 Function Switch Standby Read 10 Suppression Switch . display → Suppression Switch 0.0 → Autosal display (Autosal).
- Function Switch Read Standby .
(7) 20 . .

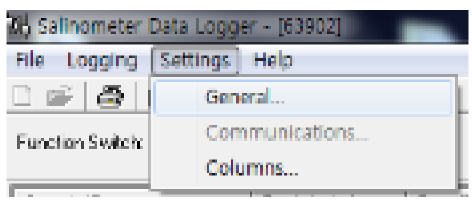


Figure 3.7:

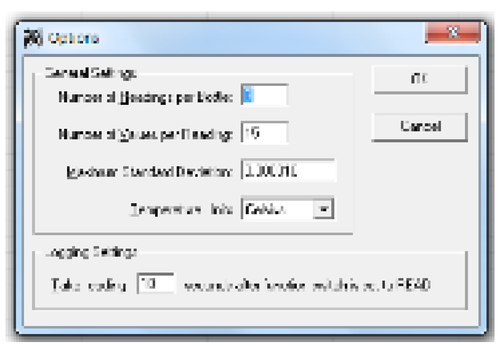
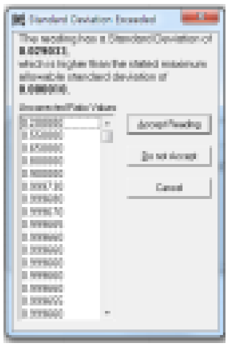


Figure 3.8:

- ( ) pump flushing . 3~4 Function Switch Read 10 Suppression Switch . display . → Sal. 35 Suppression Switch 1.9 → 20 .

- 1200 Reading Function Switch Read Standby .
- Maximum Standard Deviation 0.000010 . Accept Reading



Autosal .

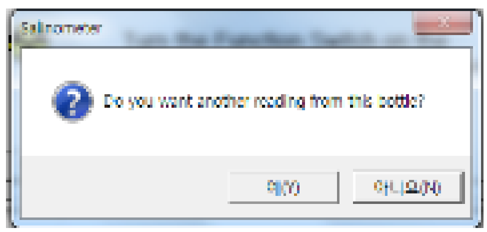


Figure 3.9:

.

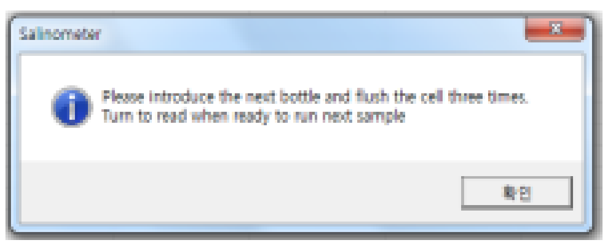
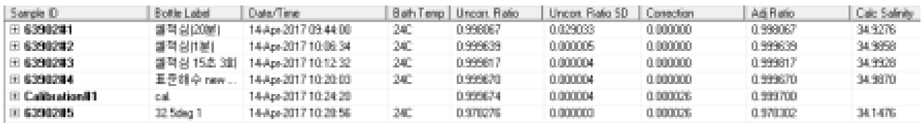


Figure 3.10:

.

- Bottle Label .
- 63902#3 3 . 1 (15) 1 . (8) ( ) 3 15 .
- 3 display ±5 .



Sample ID	Bottle Label	Date/Time	Bath Temp	Uncor. Ratio	Uncor. Ratio SD	Correction	Adj Ratio	Calc Salinity
63902#1	[illegible](20분)	14-Apr-2017 09:44:00	24C	0.998067	0.029033	0.000000	0.998067	34.9276
63902#2	[illegible](1분)	14-Apr-2017 10:06:34	24C	0.999639	0.000005	0.000000	0.999639	34.9858
63902#3	[illegible] 15초 3회	14-Apr-2017 10:12:32	24C	0.999817	0.000004	0.000000	0.999817	34.9928
63902#4	표준해수 new ...	14-Apr-2017 10:20:03	24C	0.999670	0.000004	0.000000	0.999670	34.9870
Calibration#1	cal.	14-Apr-2017 10:24:20		0.999674	0.000004	0.000026	0.999700	
63902#5	32.5deg 1	14-Apr-2017 10:28:56	24C	0.970276	0.000003	0.000026	0.970302	34.1476

Figure 3.11:

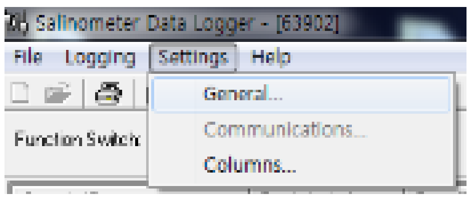


Figure 3.12:

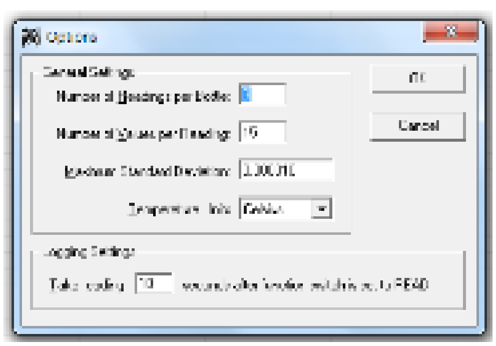


Figure 3.13:

3.7.8 Autosal (standardization potentiometer)

Autosal Warming-up .
(1) .
(2)Autosal Pump Switch 3 Flushing Pump Switch .
(3) Pump(flow rate : 1) Switch Pump Switch .
(4) 3~4 .
(5)Function Switch Read 10 Standardization Potentiometer ( ), Potentiometer K15 2 ( ).
K15 = 0.99996 , 0.99996 × 2 = 1.99992 .
, 1.99992 display Potentiometer .
(6)30 Reading Function Switch Read Standby .
(7)display K15 2 3 (flushing) (5)~(6) .
4 Bottle Counter . ±5 Autosal .

3.7.9 Autosal ( )

Standardization potentiometer Autosal .
Autosal Warming-up .
(1) . (2)Autosal Pump Switch 3 Flushing Pump Switch .
(3) Pump(flow rate : 1) Switch Pump Switch .
(4) 3~4 .
(5)Function Switch Read 10 Suppression Switch (display → Sal. 35 Suppression Switch 1.9) → Reading Function Switch Read Standby → 3 (flushing)
(6) flushing .

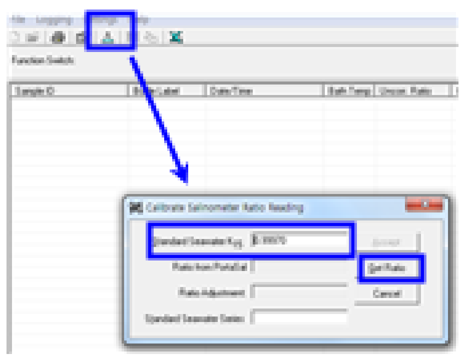


Figure 3.14:

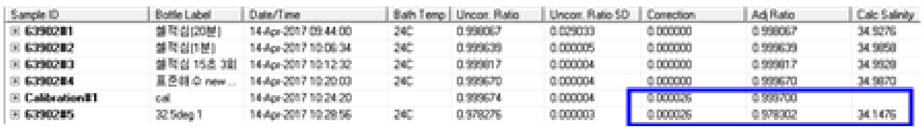
- .
- Standard Seawater K15 21 K15 .

- Get Ratio Function Switch Read 10 Suppression Switch (display → Sal. 35 Suppression Switch 1.9).

- Reading Function Switch Read Standby .

- Autosal display Accept .

- Ratio Salinity .



Sample ID	Bottle Label	Date/Time	Bath Temp	Uncor. Ratio	Uncor. Ratio SD	Correction	Adj Ratio	Calc Salinity
63902#1	[illegible](20분)	14-Apr-2017 09:44:00	24C	0.998067	0.029033	0.000000	0.998067	34.9276
63902#2	[illegible](1분)	14-Apr-2017 10:06:34	24C	0.999639	0.000005	0.000000	0.999639	34.9858
63902#3	[illegible] 15초 3회	14-Apr-2017 10:12:32	24C	0.999817	0.000004	0.000000	0.999817	34.9928
63902#4	[illegible] new ...	14-Apr-2017 10:20:03	24C	0.999670	0.000004	0.000000	0.999670	34.9870
Calibration#1	cal	14-Apr-2017 10:24:20		0.999674	0.000004	0.000026	0.999700	
63902#5	32.5deg 1	14-Apr-2017 10:28:56	24C	0.978276	0.000003	0.000026	0.978302	34.1476

Figure 3.15:

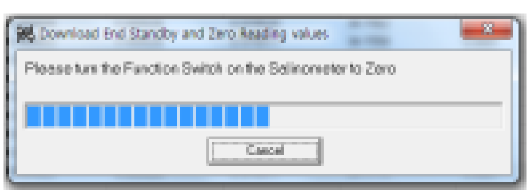
3.7.10

(1) .
(2)Autosal Pump Switch 3 Flushing Pump Switch .
(3) Pump(flow rate : 1) Switch Pump Switch .
(4) 3~4 .
(5)Function Switch Read 10 Suppression Switch (display) → Reading Function Switch Read Standby → 3 (flushing) .

3.7.11 Autosal

(1) (6) .
(2)Function Switch Standby Read 10 Suppression Switch (display → Suppression Switch 0.0 → Autosal display (Autosal).
(3)Function Switch Read Standby .

(4)File → Close .



(5)Function Switch Standby Zero Zero .
(6)Function Switch Zero Standby .
(7)AUTOSAL (AUTOSAL).
(8)AUTOSAL .

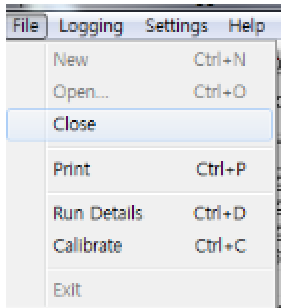


Figure 3.16:

3.7.12 Autosal

(1)OSIL
- 20mL 10mL Decon 90 methanol(95%) 170mL . methanol
.
- flushing 3~4 20 .
- flushing(10) .
- 400mL flushing .
- drain .
- .

(2)Guildline
- CLR, Isopropyl Alcohol, 200mL .
- CLR flushing 3~4 20 .
- CLR flushing(10) .
- Isopropyl Alcohol flushing 5~7 10~15 .
- Isopropyl Alcohol flushing(10) .
- 400mL flushing .
- drain .
- .

3.7.13

(1) . . .
. .

(2)cell drain . cell drain
.

(3) . 1~2 , digit . flushing
.
- flushing . 0.001psu .

(4) . .

(5) Autosal 4 (bath
) , impeller (O ring) .

(6)30 Autosal 3 ~6 . (7)

4~5 . .
(8) (15%) . 2ppm .
.
(9)display ±1 digit 0.0002psu (35psu).
(10)bath temperature ±0.5 mK ±2 digits .

3.8

Cox, R.A., Culkin, F., Riley, J.P. (1967) The electrical conductivity/chlorinity relationship in natural sea water. Deep-Sea Research, 14:203-220 Saunders, P.M. (1990) The international temperature scale of 1990, ITS-90. WOCE Newsl. No. 10 Stalcup, M.C.(1991) Salinity measurements. WHP Operations and Methods Muller, T.J. (1999) Determination of salinity. In Methods of Seawater Analysis. Eds Grasshoff, K., Kremling, K., Ehrhardt, M. Wiley-VCH (2013) 2013-230

Chapter 4

4.1

60

. (2013-230) Grahm 250ml Erlenmeyer Flask Borosilicate Watch Glass 100ml Borosilicate

. (KIOST modified MOF 2013-203) ,

, .

4.2

60 ,

.

( ). (I^-) (I_2) ( ). (I_2) (I^-) (I^{3-}) ( ). (I^{3-})) (I^-)) ( ). (I^{3-})) ( ).

.

(1) $8MnO_4{}^- +\quad \rightarrow 8MnO + 8OH^- + 6CO_2 + 2H_2O$

(2) $MnO_4{}^- + 2I^- + 8H^+ \rightarrow Mn^{2+} + I_2 + 4H_2O$

(3) $I_2 + I^- = I^{3-}$

(4) $I^{3-} + 2S_2O_3{}^{2-} \rightarrow 3I^- + S_4O_6{}^{2-}$

(5) $\quad + I^{3-} \rightarrow$

( ) .

(Biochemical Oxygen Demand)

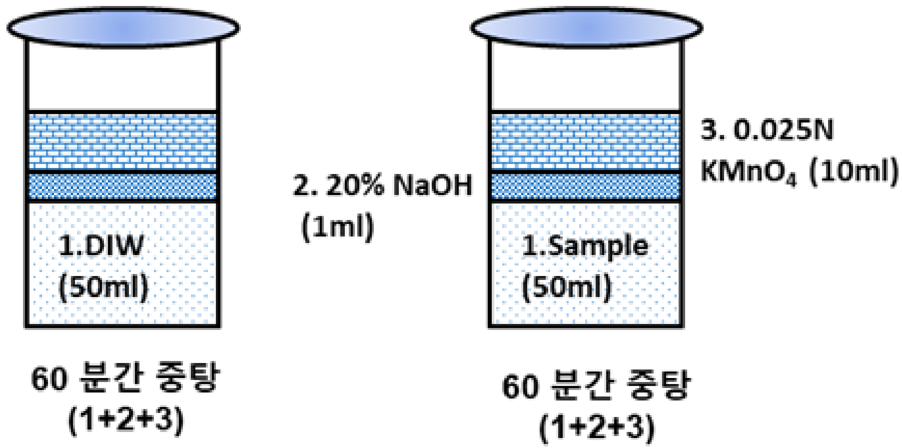


Figure 4.1:

, . 0.18~8 mgO_2/L , 95% (k=2) (MDL) 0.18 mgO2/L 0.11 mgO_2/L . 60 1/2 . 8 mg O_2/L 50 mL .

4.3

. 30 50% . .

4.4

(4.1), (4.2), (4.3), (4.4), (4.5) . 10% 3 . .

4.4.1

100 ml .

4.4.2

100 ℃

4.4.3

100ml

4.4.4

.

4.5

(; Metrohm 665 Dosimat burette, SCHOTT Instruments TITRONIC universal).

4.6

(5.1), (5.2), (5.3), (5.4), (5.5), (5.6). (5.7) .

4.6.1 20 % (w/v)

(NaOH) 20 g 100mL .

4.6.2 10% (w/v)

(KI) 5 g 50 mL .

4.6.3 50% (v/v)

(H_2SO_4) 50 mL 40 mL . 100 mL .

4.6.4 1%

1 g 50 mL 100 mL . . (Hg_2I_2) . 1 .

4.6.5 0.025 N

($KMnO_4$) 0.790 g 1000 mL . 1 2 .

4.6.6 0.01 N

($Na_2S_2O_3 \cdot 5H_2O$) 2.48 g 1000 mL .
1 ($Na_2S_2O_3 \cdot 5H_2O$) (S) 2 1(=0.5 × 2) . $2S_2O_3{}^{2-} + I^{3-} \rightarrow S_4O_6{}^{2-} + 3I^-$;
$[S^{2+}] \rightarrow [S^{2.5+}]$; Δ $= 0.5$

. .

$I^{3-} + 2S_2O_3{}^{2-} \rightarrow 3I^- + S_4O_6{}^{2-}$

(S) ;(-2) → (-2.5)

4.6.7 0.001667 M (0.0100 N)

(KIO_3) 120℃ 2 . 0.3567g 1000 mL . 0.3567g , .

$$M(\ ) = \frac{1L}{(214.0g)}$$

4.7

1.1. , 0~10℃ ( ) .

4.8

4.8.1 ( )

7.1.1. 100 ml 10.0 ml (0.00167 M) . 40 mL .

7.1.2. 1 ml 50% 1 ml . (I^-) ($IO_3{}^-$) ($I_3{}^-$) ($IO_3{}^- + 8I^- + 6H^+ \rightarrow 3I_3{}^- + 3H_2O$).

7.1.3. . 1 ml . . ($I_3{}^- + 2S_2O_3{}^{2-} \rightarrow 3I^- + S_4O_6{}^{2-}$). ± 0.03 ml .

7.1.4. (IO_3^-) 1 ($S_2O_3^{2-}$) 6 . . 3 .

$$C_{Na_2S_2O_3 \cdot 5H_2O} = \frac{C_{KIO_3} \times 60.0}{V_{Na_2S_2O_3 \cdot 5H_2O}} C_{Na_2S_2O_3 \cdot 5H_2O} : Na_2S_2O_3 \cdot 5H_2O \quad (mole/L) C_{KIO_3} : KIO_3 \quad (mole/L$$

4.8.2

7.2.1. 100 mL 50 mL , 20% 1 mL . 7.2.2. 0.025 N 10.0 mL 60 . 7.2.3. 10% 1 mL , 50% 1 mL . 7.2.4. 1 mL . 7.2.4. (blank) . .

$$= \frac{C_{Na_2S_2O_3 \cdot 5H_2O} \times (V_{Na_2S_2O_3 \cdot 5H_2O;blank} - V_{Na_2S_2O_3 \cdot 5H_2O;sample}) \times 8000}{V_{sample}}$$

$C_{Na_2S_2O_3 \cdot 5H_2O}$;
$V_{Na_2S_2O_3 \cdot 5H_2O;blank}$; (L)
$V_{Na_2S_2O_3 \cdot 5H_2O;sample}$; (L)
V_{sample} ; (L)

4.9 / (QA/QC)

5 (blank) . 6.0 , . .

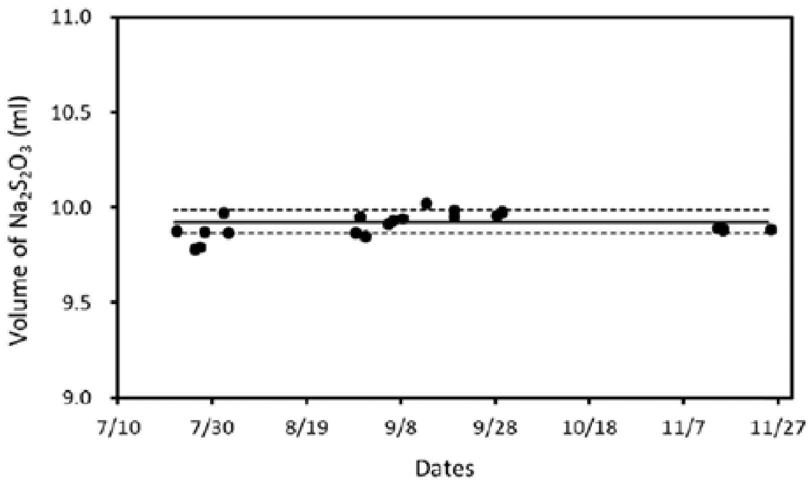


Figure 4.2:

4.10

4.11

(COD) ($K_2Cr_2O_7$) , pH . (COD) , .

Chapter 5

ADCP

5.1

Acoustic Doppler Current Profilers(ADCP) (fixed-mounted) (vessel-mounted) ADCP , , . ADCP .

Figure 5.1: Workhorse Sentinel 300 kHz ADCP

5.2

ADCP . ADCP . , ADCP ADCP . ADCP . ADCP . ADCP ADCP .

5.3

ADCP ADCP PC PC .
. ADCP ADCP
.

5.4

ADCP , . ADCP
(2.1).

300 kHz ADCP 150m , . ADCP
, . , ADCP (side lobe interference) . ADCP .

5.5

3.1. ADCP , ADCP , , .
3.2. Teledyne RD Instrument's PlanADCP software .
3.3. .
3.4. ADCP , .
.

5.6

4.1. ADCP , ADCP . · 4
, , (tilt) , (fluxgate) ( ) . PVC ,
ADCP (acoustic releaser, Benthos Model 875-A or 865-A), (Pinger, RJE Model ULB-364/37), ADCP (4.1) . 4.1 (d) 40 m(,
) ADCP . ADCP , .
ADCP (, transducer) . 30m
ADCP time-out release .

4.1.1. (Acoustic Transducer Head)
4.1.1.1. 3 (u, v, w) 1 . (Acoustic Transducer Head)
. (transceiver electronic) , 4 piezoceramic acoustic transducer . 4 90° 25° . (transduce head)
. 4 transducer( ) (300 kHz, 600kHz, 1.2 MHz) (acoustic pulse)
.

4.1.2. sensor . tilt(pitch roll) . Compass (heading) . Heading direction . Micro- controller 3
. 3 x, y, z . Tilt-x tilt-y . tilt , heading magnetic field tilt . RS232 CAN bus . heading pitch, roll .

4.1.1. 4.1.2.

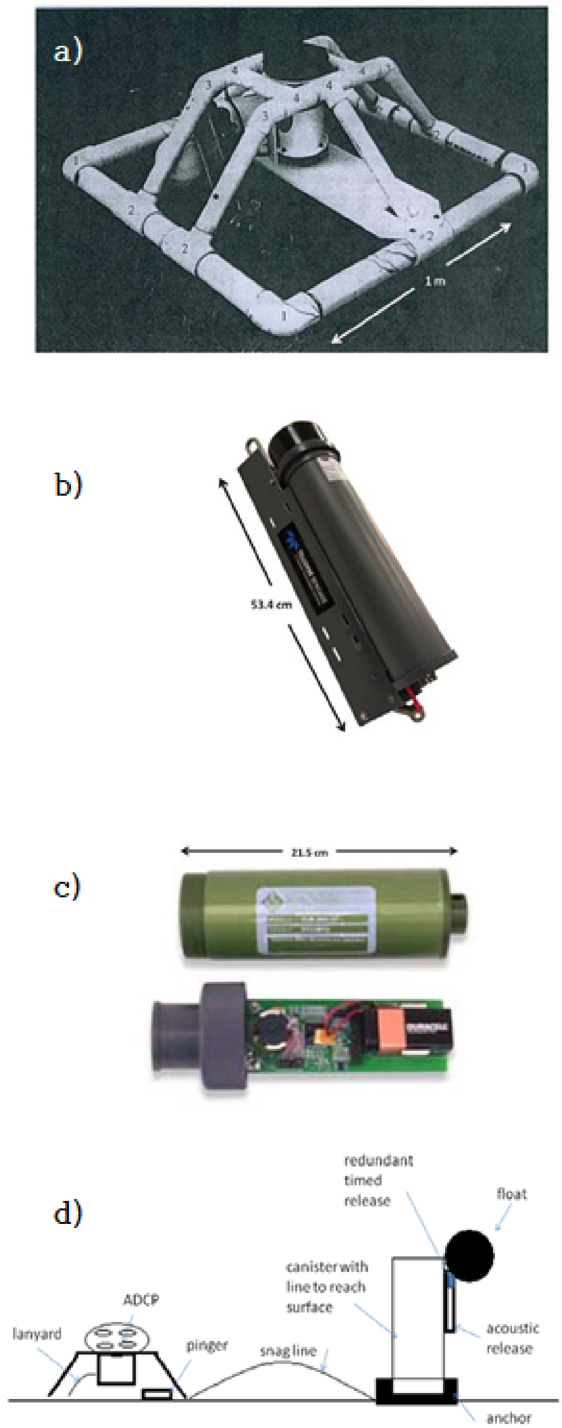


Figure 5.2: ADCP recovery system: a) mount, b) acoustic release, c) pinger, and d) detailed configuration for on-fixed deployment

4.2. Vessel-mounted ADCP , ADCP (ex.) . 4 , , , ADCP 3 . ADCP . ADCP , DGPS GGA-mode(GSA-mode) .

Figure 5.3: vessel-mounted ADCP

5.7

5.1. ADCP ( ) 2 .

5.2. ADCP . . ADCP .

5.3. (ex.) . (ADCP anti-foul paint) .

5.8

1.1.

1.2. , ,

1.3. fixed-mounted (B):

```
1.3.1. ADCP battery    ( 6.1  )
1.3.2.   (  ,   ,   ,    )
1.3.3.           , mounts, shackles, tackle   recovery system
1.3.4.    (  A )
```

1.3.5. ADCP (B)
1.3.6. recovery line tackle

1.4. vessel-mounted (B):

1.4.1. ADCP
1.4.2. DGPS ( )
1.4.3. ADCP ,
1.4.4. (B)
1.4.5. ADCP (D, E)

Figure 5.4: fixed-mounted

5.9

5.9.1

1.1.1. .(A)
1.1.2. ADCP (fixed vessel) B .

5.9.2 ADCP

1.2.1. ADCP , . ADCP e, v, w components rotate ADCP beam .

1.2.2. . 6 . 90 , ADCP 4.5 . PlanADCP software duration, vertical resolution(bin size), . ADCP 100 , . ADCP 32MB , . ADCP (, ,) . Marine fixed paint (9.0) . ADCP biofouling .

1.2.3. ADCP .

1.1.1.1. (4). ADCP ( ) . ADCP beam 3
1.1.1.2. ADCP .
1.1.1.3. ADCP ADCP beam 3 . ADCP .
1.1.1.4. . ADCP .
1.1.1.5. O-ring Dow Corning 111 valve lubricant . O-ring
1.1.1.6. . 2 .
1.1.1.2. PlanADCP . (www.rdinstruments.com for latest details).
1.1.1.3. ADCP . , , . ADCP GMT .

(1)
. ADCP 1-2-3-4 .
. Rotate flat, 360 degrees on primary axis.
. Rotate pitch/roll. lift by 10.20 degrees up on side 3 with a non-magnetic tilting block, rotate 360 degrees on primary axis.
. Rotate roll/pitch. lift by 10-20 degrees up on adjacent side, 360 degrees on primary axis.
. Final rotation. not as critical. Rotate somewhere between (and not as much), 360 degrees on primary axis.

1.1.1.1. ErAsE .
1.1.1.2. , .
1.1.1.3. Workhorse Sentinel ADCP 2.2W 5 . ADCP 1mW . ADCP 3 (ADCPlan) .
1.1.1.4. . 7.1 .

1.1.1. (Acoustic Release) .

1.1.1.1. . .

1.1.2.

1.1.2.1.
ADCP . Benthos deck box(7-2) , deck box

, ADCP . .
ADCP . ADCP , ADCP . ROV .

1.1.1.1. ADCP WinSC ADCP PCMIA . ADCP .

1.1.1.
1.1.1.1. · , . . biofouling , ADCP .
1.1.1.2. . . mount . ADCP .

Figure 5.5: DCP mount

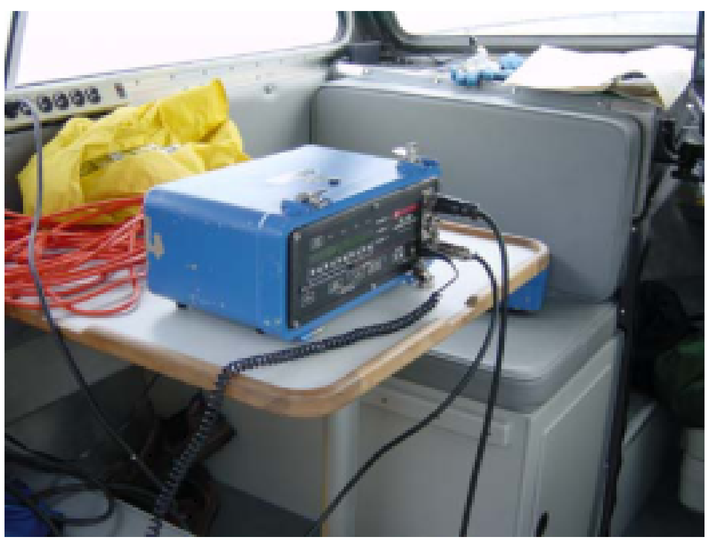


Figure 5.6: hydrophone Benthos-type deck box

Figure 5.7: ADCP mount

5.10

5.10.1

5.10.2

1.2.1. ADCP (A) , , . ADCP , B . Operation Center(OC) , . .

1.2.2. ADCP . ( )

1.2.3. ADCP . ( )

5.10.3

1.3.1. 1.3.1.1. ADCP . ADCP 1 .

1.3.2. ADCP . (1) (2) (3) (4) (5) (6) (7) (8) (9) (10) (11) (12)

1.1.1.

```
1.1.1.1.   ,   ,            .
1.1.1.2.                    (retaining strap)   ,      ,
1.1.1.3.                    . DC-111                 .
```

1.1.1. 1.1.1.1. (1) . . . . (2) 4 . . .

Figure 5.8:

(3) . (4) O . . O . 1.1.1.2. (1) . (2) . (3) . (4) . . (5) . (6) . (7) O . .

1.1.2. 1.1.2.1. ADCP . 1.1.2.2. , , . 1.1.2.3. ADCP . 1.1.1.1. O (1) O . O . O . (2) O : O . O . 0.1 mm . (3) O . , , . . (4) O (60) . . (5) DC-111 O . . . 1.1.1.1. (1) . (2) O , , . O . . (3) . (4) . 3 . (5) . 1.1.1.2. (1) .

1.1.2. 1.1.2.1. 30 VDC .

1.1.3. 1.1.3.1. .

1.1.4. 1.1.4.1. POI .

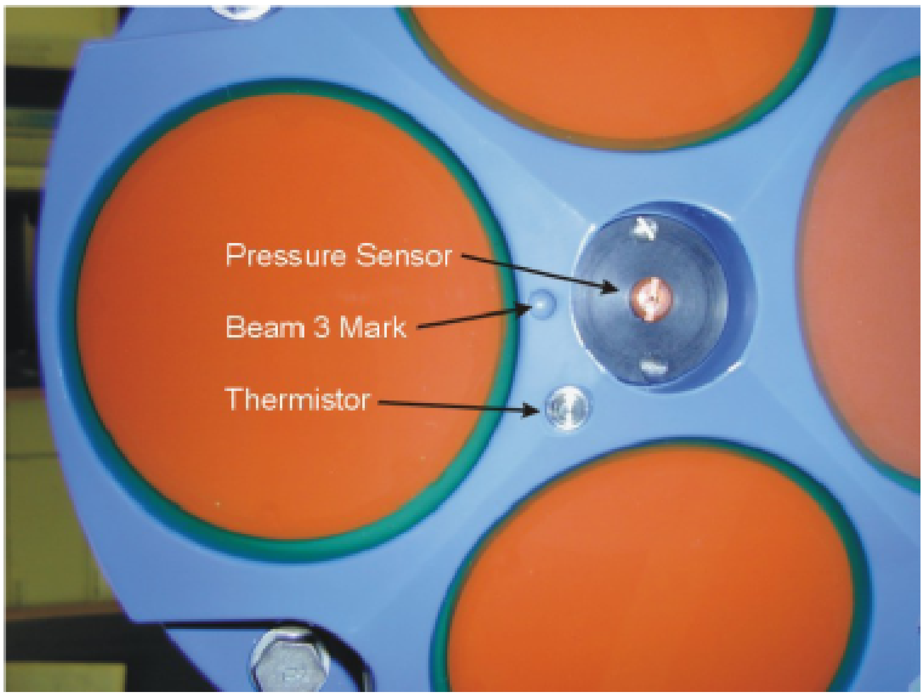
1.1.5. 1.1.5.1. . RS-232 RS-422 . .

1.1.6. 1.1.6.1. . . 7.2 . 8.4 9 . 250° 14 . .

1.1.7. 1.1.7.1. , PC , , .

1.1.8. 1.1.8.1. 100 m .
.

1.1.9. 1.1.9.1. . .



1.1.1. 1.1.1.1. . .

1.1.1. ADCP 1.1.1.1. ADCP 8.4 . . ADCP
. 1.1.1.2. BBTalk . 1.1.1.3. ADCP .
WH_RSLTS.txt . WH_RSLTS.tx BBTalk .

1.1.1.1. (B)

1.1.1.2. (B)

5.11

5.11.1

1.1.1. ADCP 4 3 (u, v, w) . (
20) , / w (u(-), v(-)) . ,
vessel-mounted ADCP . ,
.

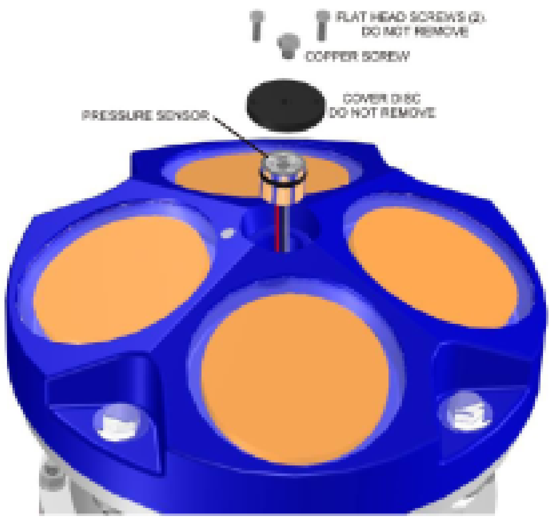


Figure 5.9:

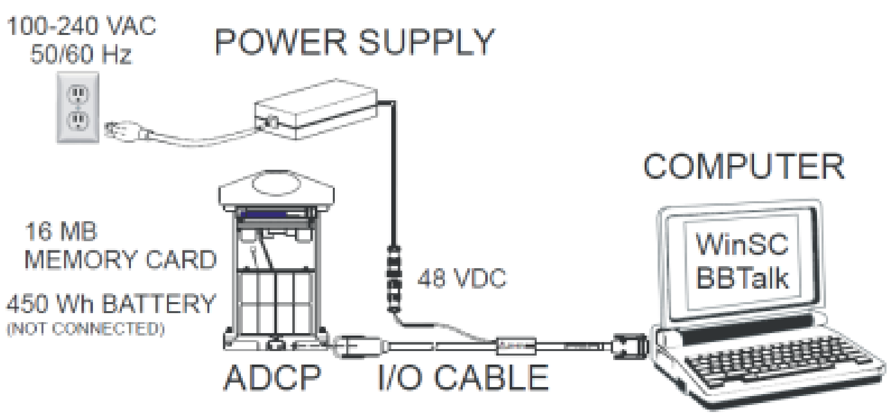


Figure 5.10: ADCP

5.11.2

1.2.1. .
. ADCP .

5.12

1.1. Environmental Assessment Program(EAP) Safety Manual
, , EAP safety manual 3 . (, ,
) .

1.2. MSDS , , , (MSDS Trilux White = http://www.yachtpaint.com/msds_pdf/YBA068_GBR_ENG.pdf). EAP HQ safey Manual .

5.13

1.1. Environmental Assessment Program, 2006. Environmental Assessment Program Safety Manual. March 2006. Washington State Department of Ecology. Olympia, WA.

1.2. WorkHorse Sentinel ADCP User's Guide, P/N 957-6163-00 (January 2001), RD Instruments Acoustic Doppler Solutions (Appendix F).

5.14 1. (Fixed-mounted ADCP)

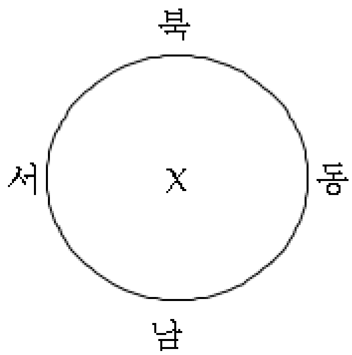
LOG SHEET FOR ADCP BOTTOM DEPLOYMENT

:
: :
: :

ADCP :
ADCP :

: :
:

ADCP (X)



:
: :

: (m):

Acoustic Release(model 875A) Serial number:
Frequency(Hz):
Release code:

Pinger? /
Snag-line? /
Timed-release? /

5.15 2. (Vessel-mounted ADCP)

LOG SHEET FOR ADCP DATA COLLECTION

:
: :
: :

Transect Number:
Transect Name:
:
Configuration :

: : :

: (m):

Select Bank: Left / Right Transect Direction (heading):
:
:

: (m):

Select Bank: Left / Right Transect Direction (heading):

:

:

:

5.16 3.

(Bottom-mounted ADCP) Office & Electronics

- Laptop Computer (w/ power cord)
- Data stick for backing-up data
- Metal Clipboard
- Float Plan x3 (Section Secretary, Contact, Field)
- Sample Logs
- Tide Table
- Cell Phone (w/ charger)
- Digital Camera
- MSDS

OC Field Supplies

- Data cable and power cord for 110-volt ship power (or battery)
- Life Jackets
- Power winch with footswitch
- Buckets
- Mount with ADCP (and new batteries)
- Acoustic release (batteries), deck unit and hydrophone
- Pinger (batteries)
- Chain, tackle, anchor ball for line canister
- Viny float, and line
- Special line that allows release of float from either acoustic or time signal
- Hefty bag to seal line cylinder
- Buoyant (floating) yellow snag-line (50 m, > ½-inch, 5000# test)
- Hose clamps (or nylon ties), and spares
- Boat hook
- ADCP Rubbermaid Action Packer, Large
- Tool Box (content details listed below)
- Cable to interface with DGPS

From Wet Lab

- *Plastic Bags
  - *Label, Electrical and Duct Tape

  - *Sharpies, Pencils and Pens
- *Connectors
- *Bottle Brushes & Paper Clip (straightened)
- *Scissors
- *Dummy plugs for ADCP
- *Nitrile Gloves, Med and Large
- *Extra Plastic Beaker
- *Kimwipes
- Deck unit and hydrophone (for recovery)

Items packed morning of departure

Contents of Bins
Large ADCP Action Packer

- Hose Clamps and/or large nylon ties
- Electrical Tape
- Duct Tape
- Zip-Ties, various sizes
- Spare Parts
- Gloves, Nitrile
- Sandwich Box with Allen Wrench
- Kimwipes
- Misc Hardware (screws, nuts, washers, insulators, Teflon tape)
- Plastic Beaker
- Brushes
- Teflon and Wooden Block

Toolbox
Screwdrivers

- Large flathead
- Small flathead
- Large Philips
- Stubby Philips

Pliers

- Large diagonal cutters (for large zip-ties)
- Small diagonal cutters (for small zip-ties)
- Needle nose
- Locking

Wrenches

- Adjustable
- Ratchet w/ drivers (various)
- Combo wrenches (various)
- Allen wrenches
- Nut drivers (various, 7 mm for heavy duty hose clamps)
- Hammer
- Electrical tape
- Knife
- Extra ADCP plugs
- Spare nuts, bolts, and ties

5.17 4.

(Vessel-mounted ADCP)

Office & Electronics

- Laptop Computer (w/ power cord)
- Data stick for backing-up data
- Metal Clipboard
- Float Plan x3 Section Secretary, Contact, Field)
- Sample Logs
- Tide Table
- Cell Phone (w/ charger)
- Digital Camera
- MSDS

OC Field Supplies

- Data cable and power cord for 110-volt ship power (or battery)
- Life Jackets
- Buckets
- Mount for ADCP to vessel (w/lanyard)
- Boat hook
- ADCP Rubbermaid Action Packer, Large
- Tool Box (content details listed below)
- Cable to interface with DGPS (if desired)

From Wet Lab

- *Plastic Bags
- *Label, Electrical and Duct Tape
- *Sharpies, Pencils and Pens
- *Connectors
- *Bottle Brushes & Paper Clip (straightened)
- *Scissors
- *Dummy plugs for ADCP
- *Nitrile Gloves, Med and Large
- *Extra Plastic Beaker
- *Kimwipes

Items packed morning of departure
Contents of Bins Large ADCP Action Packer (some items duplicative of toolbox)

- Hose Clamps and/or large nylon ties
- Electrical Tape
- Duct Tape
- Zip-Ties, various sizes
- Spare Parts
- Gloves, Nitrile
- Sandwich Box with Allen Wrench
- Kimwipes
- Misc Hardware (screws, nuts, washers, insulators, Teflon tape)
- Plastic Beaker
- Brushes
- Teflon and Wooden Blocks
- Sponges

Toolbox
Screwdrivers

- Large flathead
- Small flathead
- Large Philips
- Stubby Philips

Pliers

- Large diagonal cutters (for large zip-ties)
- Small diagonal cutters (for small zip-ties)
- Needle nose
- Locking

Wrenches

- Adjustable
- Ratchet w/ drivers (various)
- Combo wrenches (various)
- Allen wrenches
- Nut drivers (various, 7 mm for heavy duty hose clamps)
- Hammer
- Electrical tape
- Knife
- Extra ADCP plugs
- Spare nuts, bolts, and ties

Chapter 6

( )

6.1

. , , , , . .
, , (NO3-) -
(NO2-) (Continuous flow analysis, CFA) 550nm
Sulfanilamide NEDD . Method of Seawater
Analysis(1999, 3) Mg(OH)2 NaOH .
.

6.2

(, ,) 110℃ (
20) . CFA -
sulfanilamide NEDD 550nm .
((1)). - ((2)).
( ) ((3)).
( ) ((4)). 550 nm .

(1) ${NO_2}^{-}N, {NO_3}^{-}N, {NH_3}^{-}N$, organic-$N$, particulate form
+ Alkaline oxidizer $(K_2S_2O_8 + H_3BO_3 + NaOH) \rightarrow {NO_3}^{-}N$

(2) ${NO_3}^{-} + Cd + 2H^{+} \rightarrow {NO_2}^{-} + Cd^{2+} + H_2O$

(3)

(4)

SFA (2, 2006) (Segmented flow analysis, SFA)
0~6 mg N/L(0~43 mol N/L) , 0.2 mg N/L(1.43 mol N/L)
7 0.02 mg/L(0.14 mol N/L) . 5 mg N/L(35.7 mol N/L) 10
(CV) 3% .

6.3

.

U.S. EPA Method 353.2 .

6.4

(4.1), , , (4.2), (4.3), (4.4), TrAAcs800 system(4.5) . 10% 3 . .

6.4.1

NIST Class A 0.05% . . 2-3K . (Kolthoff et al., 1969; Weast, 1985). . . polymethylpentene (PMP), polypropylene(PP) . . 3% .

6.4.2

(: HDPE, PP) . 10% (5.1.5.1) 3 . .

6.4.3

0.01 mg 0.001 g .

6.4.4

. 0.1% . . . . / , , . , . . / . .

6.4.5

SEAL TrAAcs800 . (D2BX-02) , . . (1.3 kgf/cm2(0.13MPa)) .

6.5

(5.1), (5.2), (5.3), (5.4) .
1 .

< 1. >

6.5.1

. (5.1.1), (5.1.2), (5.1.4, 5.1.5) .

1.1.1. (Ultra Pure Water, UPW): (Reverse Osmosis Membrane, RO membrane) 18.2 MΩ . . 18.2 MΩ ( ) . . , (Electrodeionization module, EDI module) .

1.1.2. (Artifical Seawater, ASW): .

1.1.2.1. Sodium chloride(NaCl) - 35 g 1.1.2.2. Sodium hydrogen carbonate($NaHCO_3$) - 0.5 g 1.1.2.3. 1000 mL ( ) Sodium chloride 35 g, Sodium hydrogen carbonate 0.5 g 800 mL 1000 mL .

1.1.3. 50% Triton X-100 : Sigma Triton X-100 Isopropanol 50:50 . . 100 mL 1 .

1.1.3.1. Triton X-100(Sigma) - 50 mL 1.1.3.2. Isopropanol or Ethanol - 50 mL 1.1.3.3. Triton X-100 50 mL Isopropanol(Ethanol) 50 mL 100 mL .

1.1.4. Wash-Triton X-100 : . 1000 mL 50% Triton X-100 (5.1.3) 2 mL .

1.1.5. 1N (1N NaOH): (1) , .

1.1.5.1. Sodium hydroxide(NaOH) - 20 g 1.1.5.2. 300 mL 500 mL Sodium hydroxide 20 g 500 mL . 500mL .

6.5.2

(, ,) , , , .

1.1.1.

1.1.1.1. Potassium peroxodisulfate (K_2SO_8) - 25 g 1.1.1.2. Boric acid (H_3BO_4) - 10 g 1.1.1.3. Sodium Chloride (NaCl) – 1 g 1.1.1.4. Sodium Sulfate (Na_2SO_2) – 1 g 1.1.1.5. 5N Sodium hydroxide solution (5N NaOH) – 4 mL 1.1.1.6. 1000 mL 5.2.1.1 ~ 5.2.1.5 800 mL 1000 mL . .

1.1.2. 5N

1.1.2.1. Sulfuric acid(ACS grade, Analar Pro Analysi) - 70 mL 1.1.2.2. 500 mL 300 mL Sulfuric acid 70 mL . 500 mL .

1.1.3. Imidazole buffer

1.1.3.1. Imidazole - 30 g 1.1.3.2. Sulfuric acid(ACS grade, Analar Pro Analysis) - 4 mL 1.1.3.3. Triton X-100, 50% - 1 mL 1.1.3.4. 1000 mL Imidazole 30g 800 mL 4 mL 1000 mL . Triton X-100 50% 1 mL .

1.1.4. Sulfanilamide

1.1.4.1. Sulfanilamide - 5 g 1.1.4.2. Hydrochloric acid (ACS grade, Analar Pro Analysis) - 50 mL 1.1.4.3. 500 mL Sulfanilamide 5g 300 mL 50 mL 500 mL . .

1.1.5. NEDD

1.1.5.1. N-(1-naphthyl)ethylenediamine Dihydrochloride ($C_{12}H_{14}N2$ 2HCl) – 0.5 g 1.1.5.2. Hydrochloric acid (ACS grade, Analar Pro Analysi) - 5 mL 1.1.5.3. 500 mL NEDD 0.5 g 300 mL 5 mL 500 mL . .

6.5.3

, Wood et al.(1967) - . (, (open tube cadmium reactor, OTCR)) - . Wood et.al(1967) 0.5-2 mm . , . (Zhang et. al., 2000). . . (carry-over effect) . Patton (1982) open tube cadimum reactor(OTCR) . (Nydahl, 1976; Olson, 1980; Collos et al., 1992; Garside, 1993). , . Zhang et.al.(2000) OTCR OTCR OTCR 40 M 10-15 100% . OTCR .

(Grasshoff, 1964; Strickland and Parsons,1965) Imidazole(Nydahl, 1976) . pH 8.5 . . . pH . .

$$2{NH_4}^+ \leftrightarrow 2NH_3 + 2H^+ \quad (2) \quad Cd^{2+} + 2NH_3 \rightarrow [Cd(NH_3)_2]^{2+} \quad (3)$$

(2) (2)
(3). .
. Rho et al.(2015) OTCR
pH .

1.1.1. Stock Copper Sulfate Solution 2% 1.1.1.1. Copper Sulfate($CuSO_4 \cdot 5H_2O$) - 10 g 1.1.1.2. Copper Sulfate 10 g 500 mL 300 mL 500 mL .

1.1.2. Daily Working Imidazole buffer(5.2.5)

6.5.4 (Standard Solution)

1.1.1. Stock Nitrate Standard Solution(10,000 M)

1.1.1.1. Potassium Nitrate(KNO_3) 0.255 g 105~110℃ 2 . . 1.1.1.2. Potassium Nitrate 0.2550 g 0.01 mg 0.001 g 0.00001 g . ( ). 1.1.1.3. 250 mL 0 . 150 mL . 150 mL . Potassium Nitrate 250 mL . 1.1.1.4. . , .

1.1.2. Daily NO3 (Calibration Standards)

1.1.2.1. Stock nitrate standard solution(5.4.1) 5 , . 1.1.2.2. , (Std.A, 60 M) . 1.1.2.3. 500 mL 0 . 1.1.2.4. (5.4.1) 3 mL 500 mL (5.1.2) 500 mL . 500 mL (mol/kg). (mol/L, M) (35‰) . 1.1.2.5. AACE Method Calibrant .

1.1.2.6. .

6.6

1.1. . 10% (High Density Polyethylene, HDPE) (Polypropylene, PP) . 15 mL Sampler rack . . 1.2. ( ) . CTD . . . . 1.3. , 0.2 m PES(Polyethersulfone) membrane . HDPE PP 500 mL 0.2 m PES . 50 mL 3 . 1.4. 8 . 8

(-80 ℃) . .
. .

6.7

(5.4.2) . . 2
. . .

6.8 (Quality Control and Quality Assessment, QA/QC)

6.8.1

(Accuracy) (Precision) . (Quality Control, QC), (Quality Assessment, QA), (Accuracy), (Precision) . Dickson(2007) "Guide to Best Practices for Ocean CO2 Measurement" .

1.1.1. (Quality Control) . , , , .

1.1.2. (Quality Assessment) . .

1.1.3. (Accuracy) (Bias) (Precision) . . . .

= [- /] × 100

1.1.4. (Precision) (random error) , ... (absolute standard deviation), (relative standard deviation, RSD), (variance), (coefficient of variation, CV), (relative percent difference), (absolute range of a series of measurement) . RSD .

% RSD = [(s)/] × 100

1.1.5. (Method Detection Limit, MDL)

. , , . , . EPA 99% 0 . 99% 0 99% . 1% 0 . ( ). , , , . , . , , . , . 8.6 .

6.8.2 (Standard Operating Procedures, SOP)

, . .
.

-
-
- , ,
- ( )

(gain) .
, . Seal AACE
. Water check, Reagent check , , detector energy
. Drift correction, Baseline correction,
Recovery detection .

6.8.3 (Internal Checks)

. , , .

1.3.1. .
.

1.3.2. ( ) (~1000) . ( ) ,
. 10L 1 mL .
1 . ( )
. ( ) .
( ) (1%) .

1.3.3. Van Ooijen and Bakker(1992)
. . CFA
. 0.1% . ,
60~80% . . (1
10) .

6.8.4 (External Quality Checks)

. . (Certified
Reference Materials, CRM), (Reference Materials, RM) .
. (,), ,
. .
, (GO-SHIP,CLIVAR, GEOTRACES)
.

1.4.1. : KANSO Technos (RMNS)
SCOR Nutrient WG147 JAMSTEC 5 (2 3) .

100 mL . Eurofins . 1
. SCOR-JAMSTEC KANSO (SI) . , ,
Chemicals Evaluation and Research Institute(CERI) Japan Calibration
Service System(JCSS), National Metrology Institute of Japan(NMIJ)
. Merck KGaA National Institute of Standards and
Technology(NIST) (SRM3150) . GO-SHIP
SI . 1.4.2. / :
. . . Scripps
Institute of Oceanography Royal Netherlands Institute for Sea Research
2 .
. . ( )
. ( ) . ( ) ,
. . ,
( ) . ,
. / ( ) ( ) .

6.8.5

, (Quality Control, QC) .
. , . .

1.5.1. ( ) , , .
/ . , , ,
. + ( ) , .
. , .

1.5.2. . GO-SHIP (CLIVAR) WOCE
CCHDO(cchdo.ucsd.edu) . GLODAP .
. .

6.8.6

1.6.1. : . .
.
.

1.6.2. : . .
. ( ) .
. . ,
.

1.6.3. : 7 .
. 1~5 .
10 1 . , .
. . .
.

1.6.4. < < 10* .

1.6.5. : 7 . 8 .
(, ,) . .
7 1 .
.
(,) 7 .

1.6.6. : 1 .
. ,
.

1.6.7. : . batches 7
, .
.

1.6.8. : (1) (s) , (2) Students t-value , (3)
(s) ( ) .

Sample standard deviation (s):

$$s = \sqrt{\frac{\Sigma(x-\bar{x})^2}{n-1}}$$

$\bar{x}$: sample mean; n-1: degree of freedom;

Population standard deviation ( ):

$$\sigma = \sqrt{\frac{\Sigma(x-\mu)^2}{n}}$$

μ: population mean; n: number of population

$= t_{(n-1,\ 1-\infty=0.99)} \times s$
$t_{(n-1,\ 1-\infty=0.99)}$: 99% n-1 students' t value
s :

95% chi (X2/df) .

```
LCL = 0.64* MDL
UCL = 2.20* MDL
```

LCL UCL 7 95% .

. .
. .
0.15 0.2 .

1.6.9. S/N : / 2.5-5 . S/N . /
2.5 . . / 10
. . / 10 .
.

$(S/N)_{est} = X_{ave}/s$
X_{ave}:
s:

1.6.10. : (1). . . 1 . 5 .

(1) 10 ? .
(2) ? .
(3) ?
(4) Signal/Noise (S/N) ?
(5) ?

1.6.11. : 0.05 mg/L . . 1, 5, 10 mg/L, . 1 . 0.05 mg/L 5 0.25 mg/L . 0.05~0.25 mg/L . MDL_cal_example.xlsx .

6.8.7

1.7.1. : .

-
-
- , , ,
- , ,
-
- , ,
-
-
-
- /
-
-
- ( )
- ( )
- ( ) ,
-

1.7.2. : . .

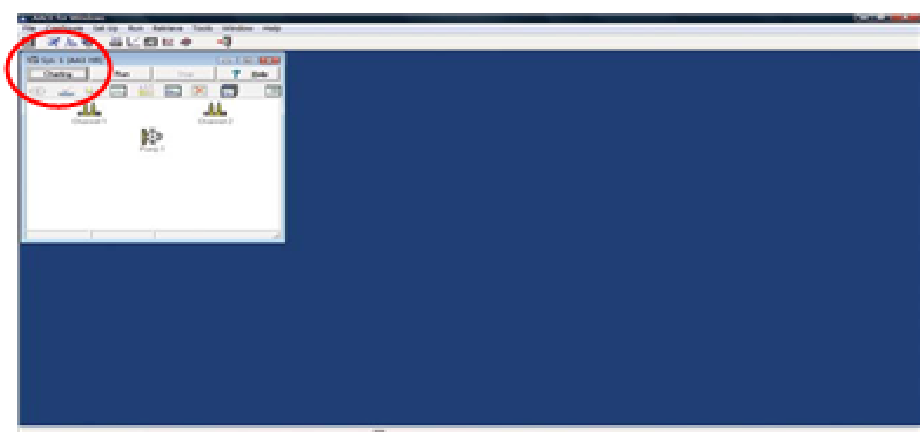
6.9

6.9.1

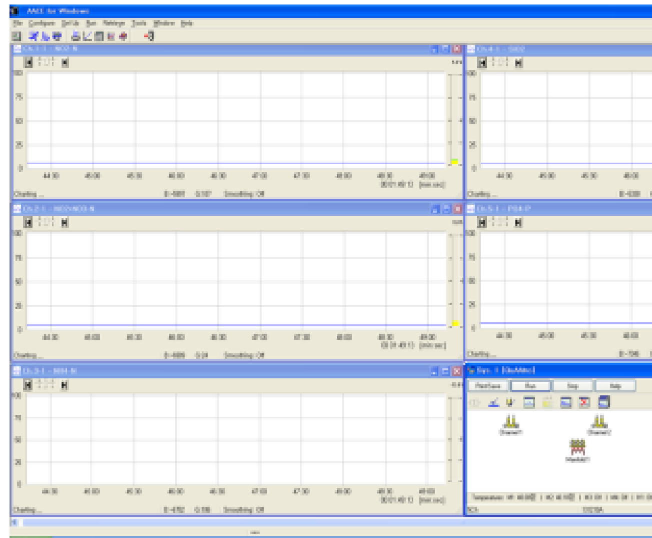
1.1.1. 1.1.1.1. TrAAcs 800, sampler, , , . 1.1.1.2. system wash solution(: wash triton-X, : wash SDS, :) Auto

sampler Sample wash solution . 1.1.1.3.
. . 1.1.1.4. .

1.1.2. (AACE) 1.1.2.1. AACE .



1.1.2.2. AACE .



1.1.2.3. Charting 2 (,) .

1.1.2.4. smoothing 4, smoothing 12 . smoothing . Smoothing .

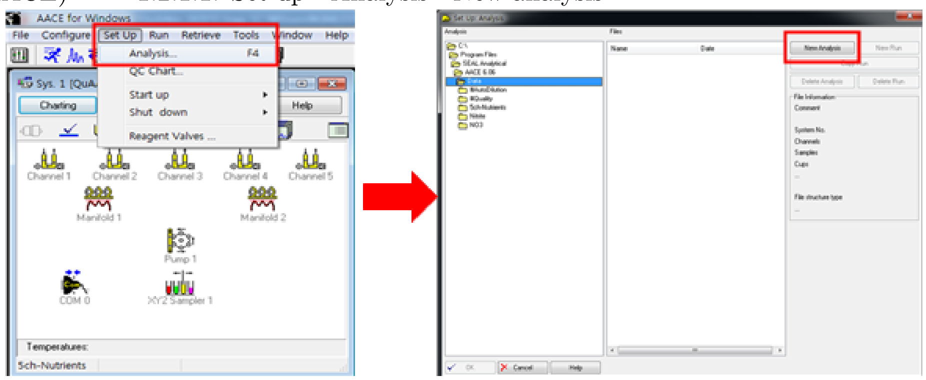
1.1.3. System Wash solution(5.1.4)( ) sampler sample wash solution . 110℃ , . baseline ±0.1% . 1 . baseline 6~20% 9.2.2.1 baseline .

1.1.4. 1.1.4.1. standard stock(5.4.1) . . 1.1.4.2. (5.2) , 5.4 5 .

1.1.5. 1.1.5.1. . . 10 mL 1 50 mL 2~3 . . 1.1.5.2. 24 . 24 ( ). - 15 mL - −80 ℃ -

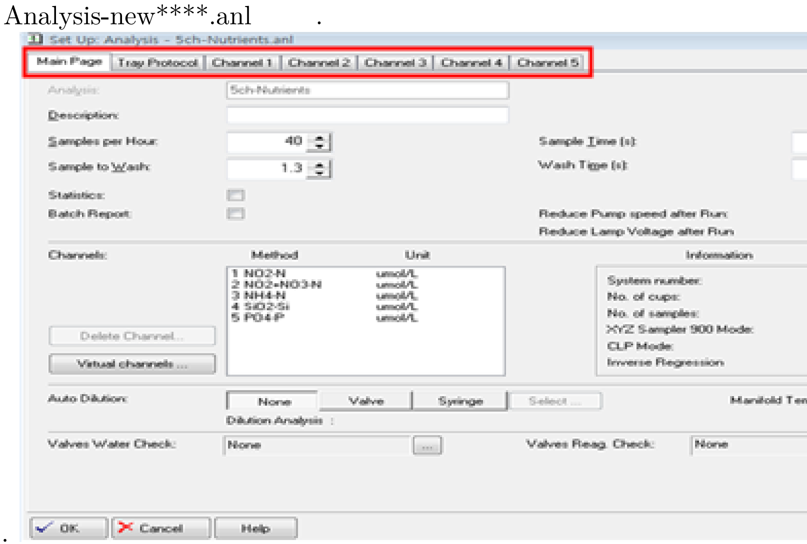
6.9.2

1.2.1. TrAAcs 800 (AACE) 1.2.1.1. Set up - Analysis - New analysis



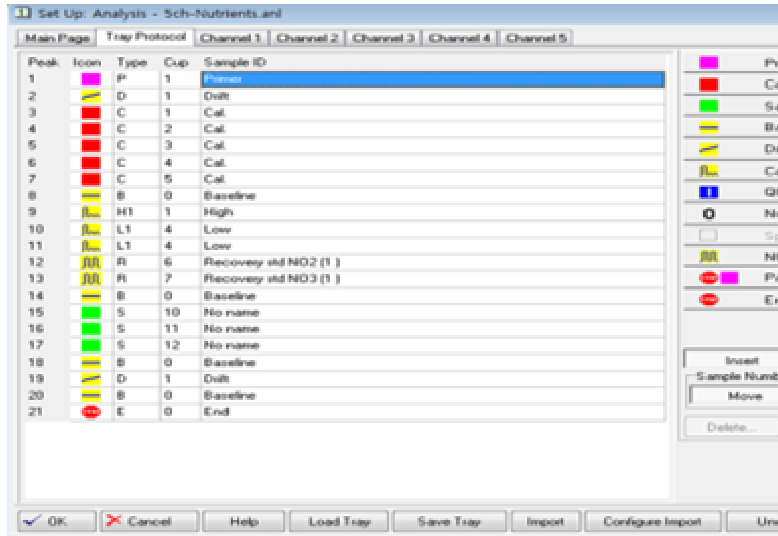
Analysis file ( ).

1.2.1.2. New analysis Set Up: Analysis-new****.anl .



Main Page, Tray Protocol, Channel 1~2 .

1.2.1.3. Main Page : Sample/Wash time . Sample/Wash time 2 /2 . peak ISAC . Peak ISAC (4) .



1.2.1.4. Tray Protocol : .

- `primer:` `primer` `peak` `peak` `tray protocol`

- `calibrants:` . . `Channel` `(9.2.1.5)`

- `drift:` .

- `carry over:` `high-low-low` `low-low-high`

- `baseline:` `baseline` . `peak` `baseline` . ,

- `Sample:` . `12` `drift`

  - MDL : 5 (1.2 M, 0.2 M). 7 (8.7).

  - NO3 Recovery: 5 M NO2, NO3 - 95% - .

$$= \frac{5\mu M \ NO_3}{5\mu M \ NO_2} \times 100(\%)$$

gain std A peak (%) . peak , gain - .

  - QC: 3 (8.2.3). 3 (8.2.2) .

  - Cup: sampler rack sampler rack . cup sampler .

1.2.1.5. Channel : channel channel (method), baseline, drift, carryover correction . (calibrants 1~10), fitting , (noise) smoothing, peak determination window time . Smoothing 4, smoothing 8 . .

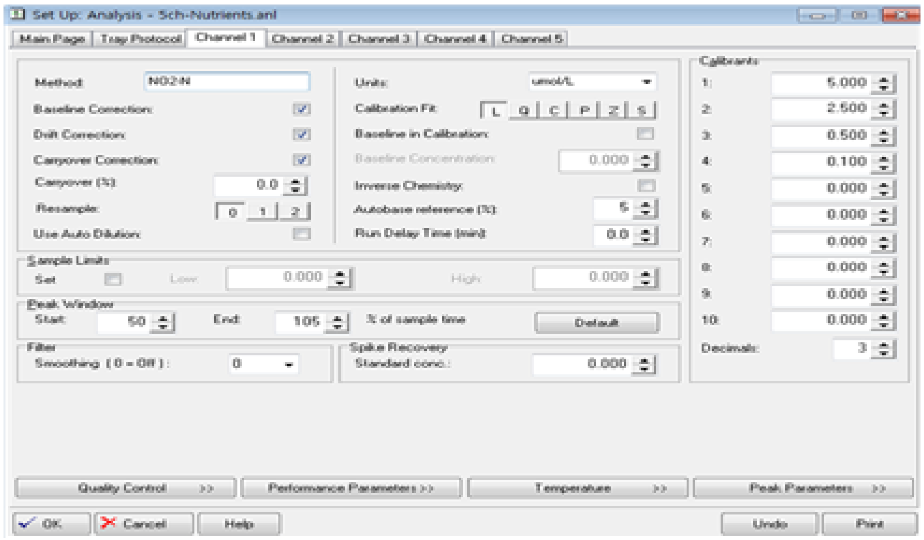


Figure 6.1:

1.2.1.6. OK Main analysis (.anl) . Set up - Analysis Analysis file system sample table .

1.2.2. baseline

1.2.2.1. 9.1.3 6~20% channel baseline 6~20% (UPW baseline). . 1.2.2.2. System wash solution(wash triton-X, wash SDS, UPW) . 1.2.2.3. Imidazole - valve - . 1.2.2.4. , baseline (Reagent blank, RB). baseline 6%~20% channel 1( ), channel 2( ) baseline . 1.2.2.5. Gain : std A (: 60 M, : 10 M) 2 2 . 20 peak channel peak 80~85% gain . baseline gain , baseline gain .

1.2.3.

1.2.3.1. 9.2.2 sample table rack(3) . rack holder rack sample probe . 1.2.3.2. run (9.2.1) . 1.2.3.3. baseline . baseline .

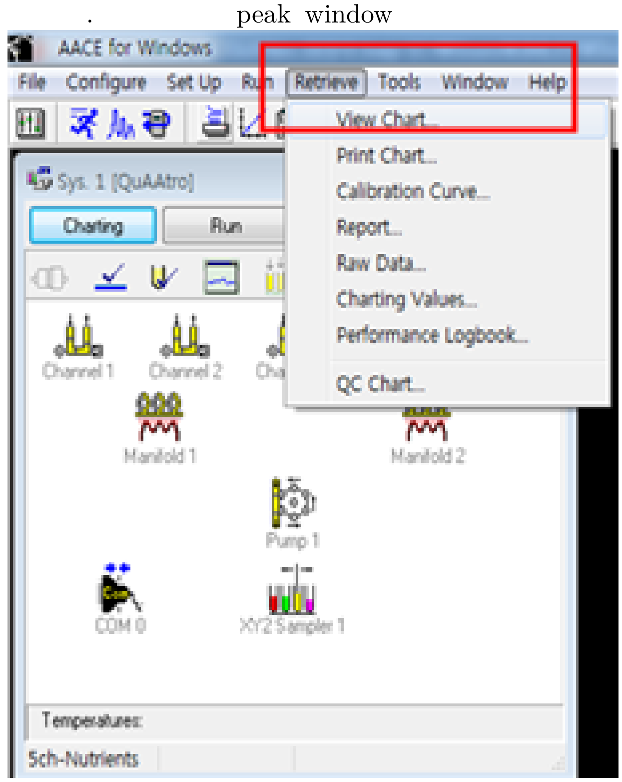
1.2.4.

1.2.4.1. - . manifold .

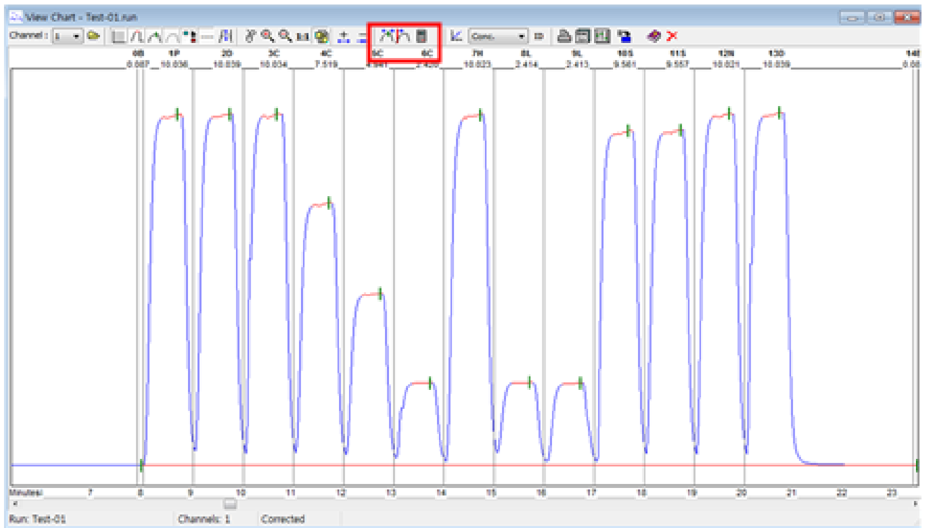
1.2.4.2. 1 manifold . 1.2.4.3. stop sampler . 1.2.4.4. / (: − 10% − 3 −).

6.10

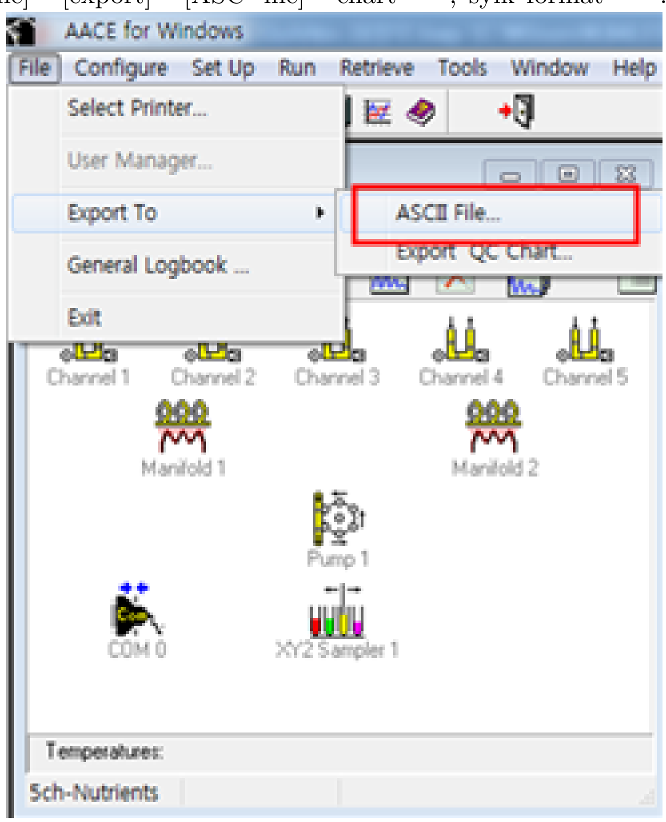
1.1. retrieve - view chart . . peak window



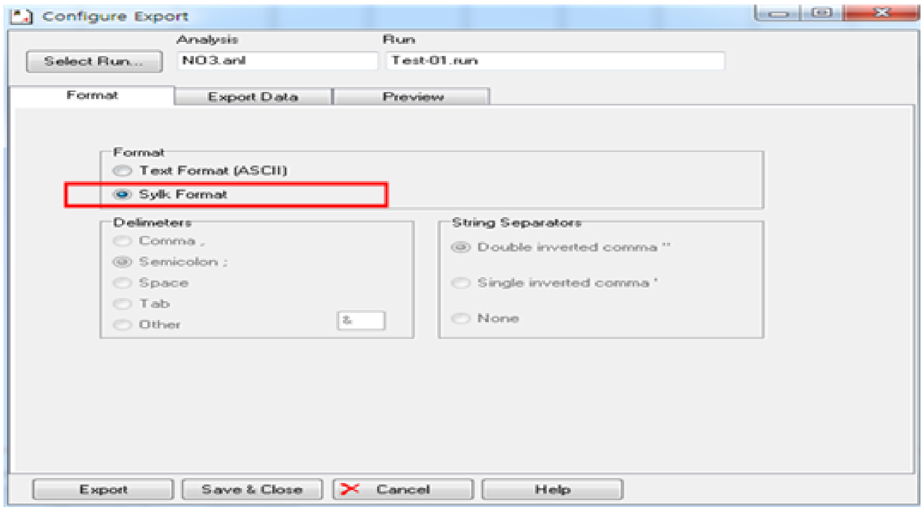
. .



1.1. [file] - [export] - [ASC file] - chart , sylk format .



excel .



1.1. .

6.11

1.1. , , , ( ) - , , Vol. 9, No. 2, p.199-206, 2006.

1.2. , 2021, p.97~104.

6.12 1. (TrAAcs 800)

6.12.1

(CFA, Continuous Flow Analysis) , flowcell .

6.12.2

1.2.1 Console(,)

1.2.2 2 proportional pump 10 . platen 12 12 .

1.2.3 1.2.3.1 Flow rate . color code . flow rate color code . 1.2.3.2 Color Code . 1.2.3.3 : , 150~200 .

1.2.4 (Manifold) , , .

1.2.5 1.2.5.1 30mm Flow cell 2 550nm, 800nm , . 1.2.5.2 Software (Gain) Baseline .

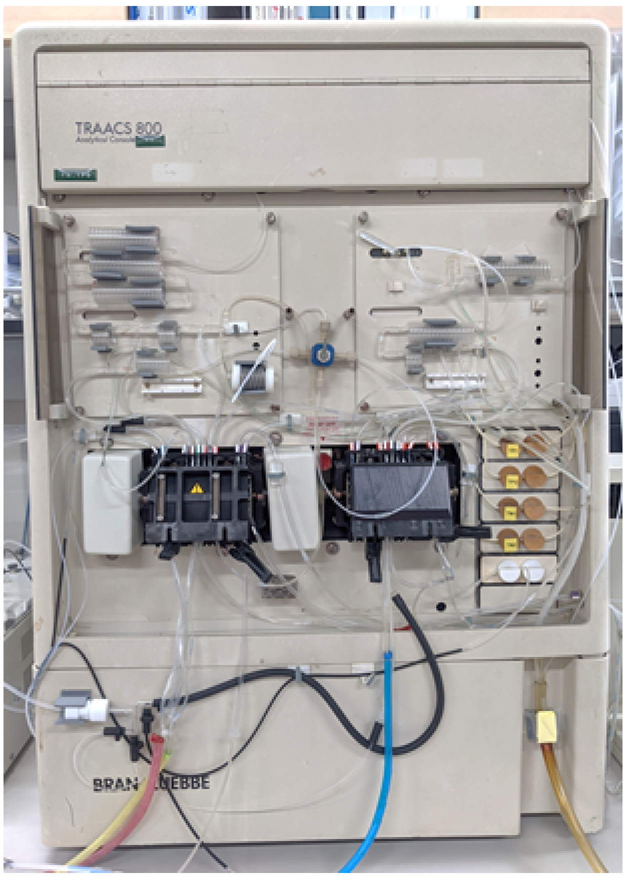


Figure 6.2:

6.12.3 Sampler

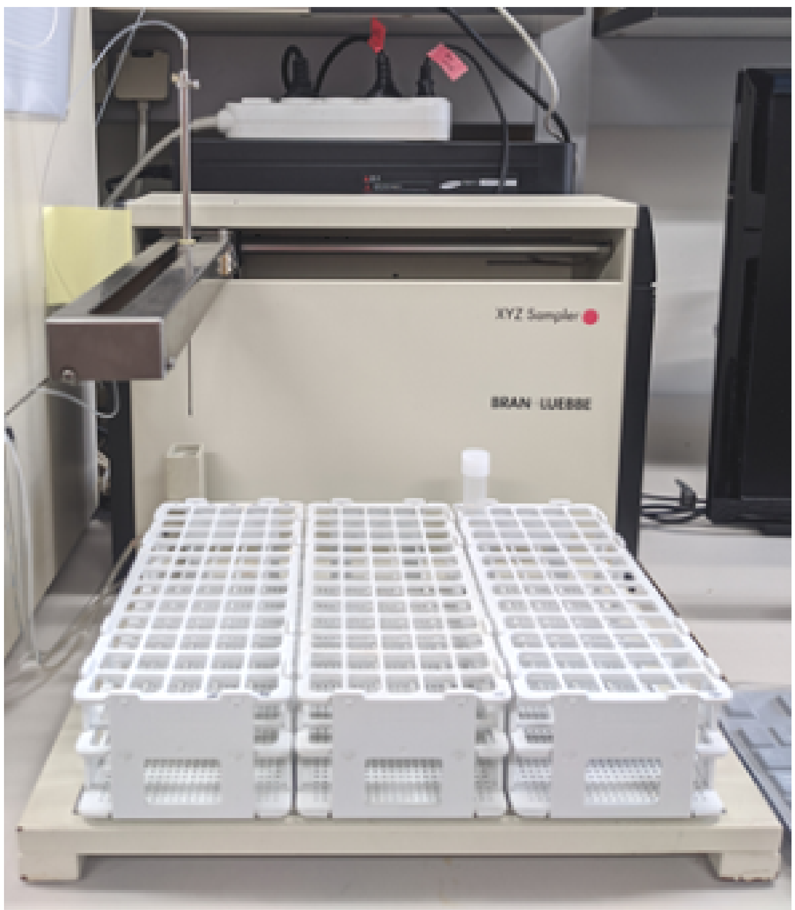


Figure 6.3:

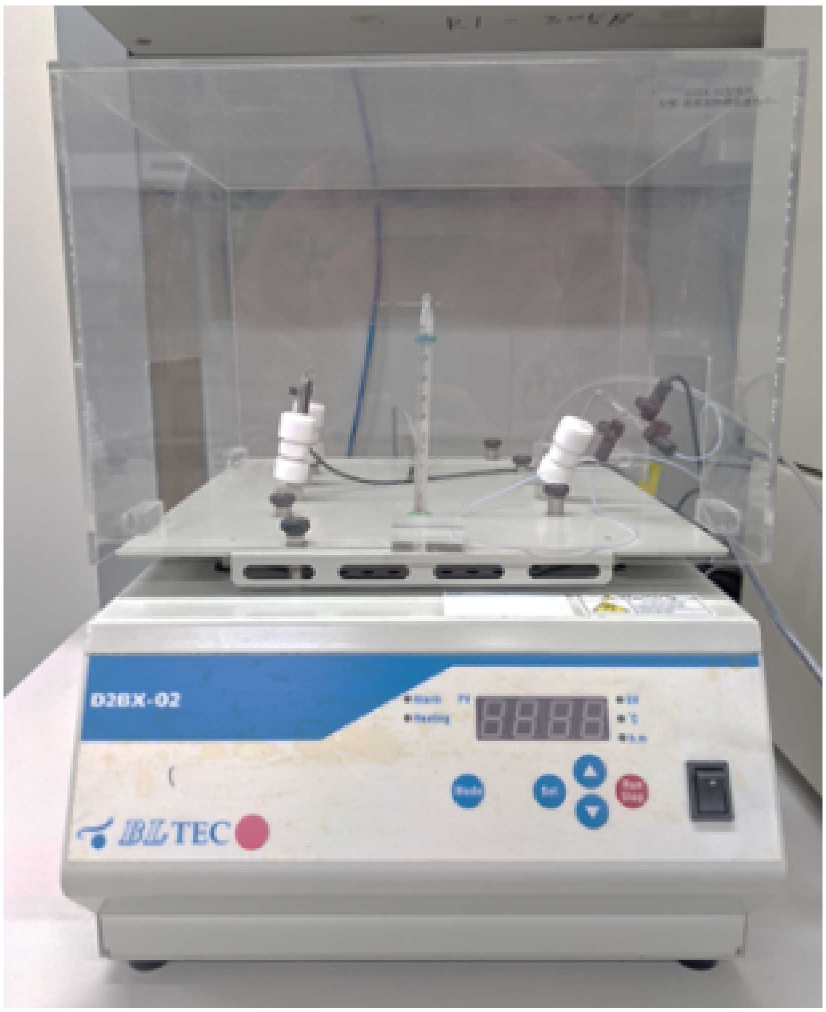


Figure 6.4:

Figure 6.5:

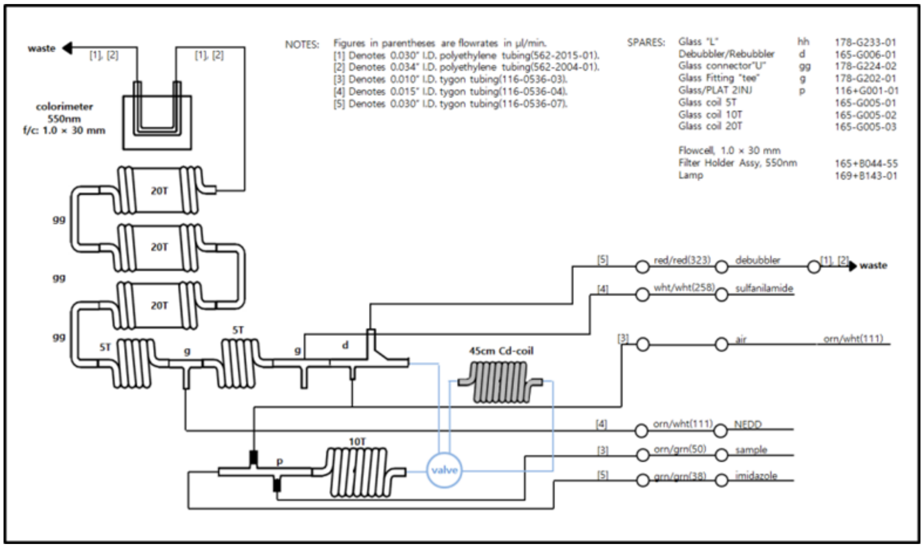


Figure 6.6:

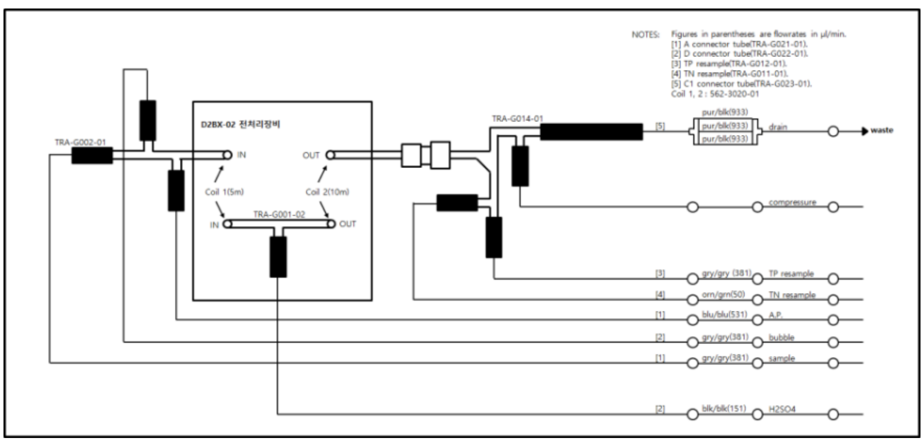


Figure 6.7:

6.12.4 (D2BX-02)

6.12.5 compressure

6.13 2. Flow Diagram

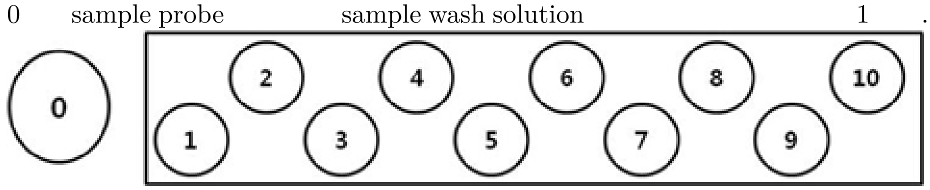
6.13.1

6.13.2

6.14 3. Sample rack position

6.14.1 Sample rack position

0 sample probe sample wash solution 1 .



6.14.2 Sample rack position

6.15 4. (Inter Sample Air Compression, ISAC)

(ISAC) , . . , .

. , . ISAC . ISAC . (+) 2~8 (3) . 60 , 3:1 . :45 :15 : 60 52~58 (57) .

. . . . . 2 . (2). . . . . . Double ISAC = + + = 57 + 45 + 15 = 117

6.16 5. Coating Procedure of Cd coil

6.16.1 (5.3)

5.1.1 10% Acetone 5.1.2 10% HCl 5.1.3 2% Copper sulfate 5.1.4 Imidazole buffer

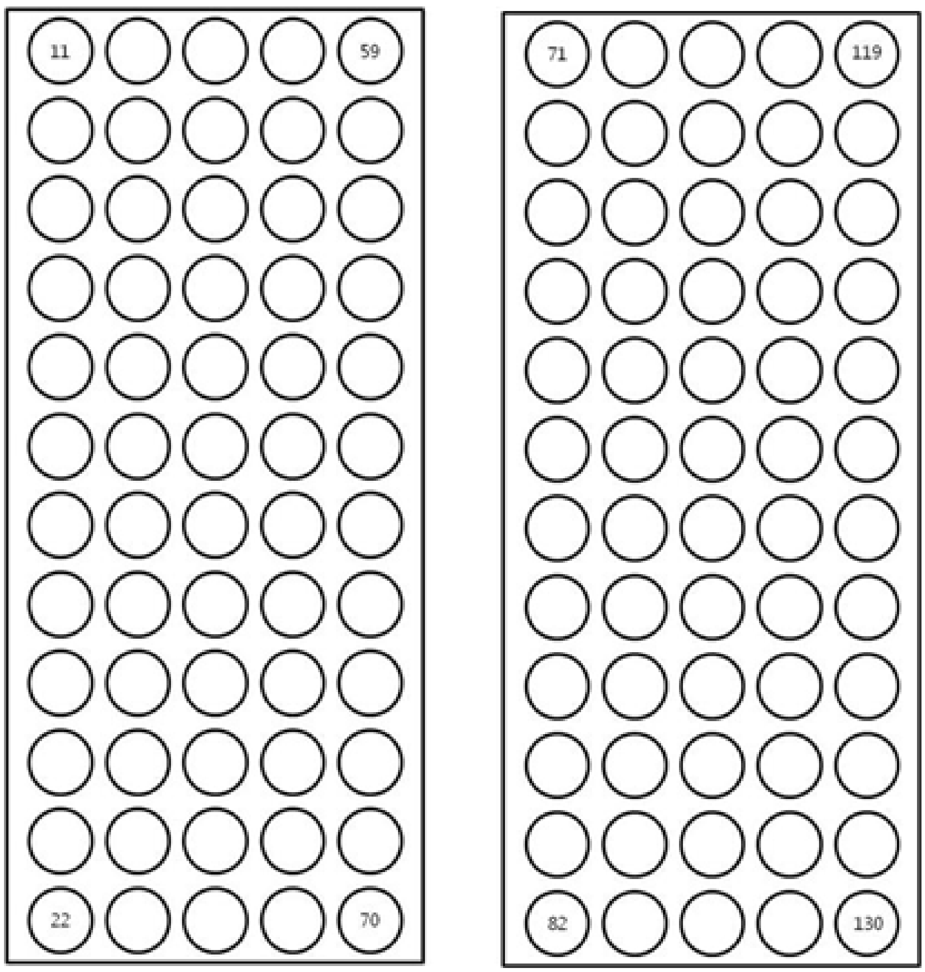


Figure 6.8:

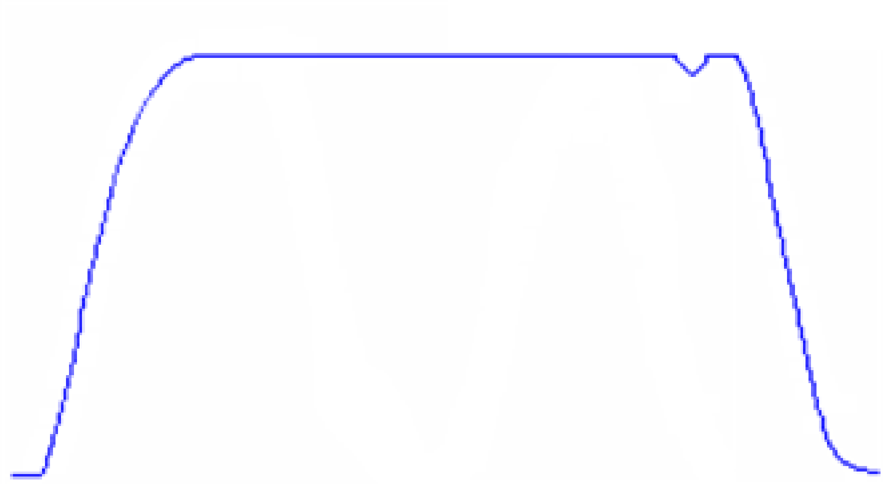


Figure 6.9:

6.16.2

5.2.1 50 mL 10% HCl, 200 mL . 5.2.3 10 mL . 5.2.4. 10 mL . 5.2.5. 1 , 2 . . 5.2.6 10 mL Imidazole buffer 10 mL . 5.2.7. 10 mL 15 5 mL, 3 mL, 2 mL . . . 5.2.9. 10 mL Imidazole buffer 10 mL . 12 . 5.2.10. 10% 12 mL 5.2.3 .

Chapter 7

7.1

(I^-) (I^{3-}) (I^{3-})
Winkler(1888) Carpenter(1965) . (2013-230)
, , .

7.2

($MnCl_2$) (NaOH/NaI) (Mn^{2+})
($Mn(OH)_2$) (1). 4 ($MnO(OH)_2$)
(2). 4 ($MnO(OH)_2$) (I^-)
(I_2) (3). (I_2) (I^-) (I^{3-}) (4).
. (I^{3-}) (I^-) .
(I^{3-}) (I^-) (I^{3-}) (5).
(I^-) (I^{3-}) (6).
(I^{3-}) (I^-) . 2 1 (I^{3-}) 1/2
(I^{3-}) , 4 ($MnO(OH)_2$) 1 (I_2) . (O_2)
1 2 (I_2) 1 (I_2) (O_2) 1/2 . (O_2) (I^{3-})
(I^-) 4 .

(1) $Mn^{2+} + 2OH^- \rightarrow Mn(OH)_2$

(2) $2Mn(OH)_2 + O_2 \rightarrow 2MnO(OH)_2$

(3) $2Mn(OH)_2 + 6H^+ + 2I^- \rightarrow 2Mn^{2+} + I_2 + 6H_2O$

(4) $I_2 + I^- = I^{3-}$

(5) $I^{3-} + 2S_2O_3{}^{2-} \rightarrow 3I^{-} + S_4O_6{}^{2-}$

(6) $+ I^{3-} \rightarrow$

0-400 mol kg-1 . 0.1% ±0.3 mol kg-1 .

7.3

.

7.4

(4.1), (4.2) . 10% 3 .

7.5

7.5.1

125 ml Pyrex . . ±0.003 ml .

7.5.2 /

3 . 1(MnCl2), 2(NaI/NaOH), 3(Sulphuric Acid) 3 1.0 ml ±0.02 ml . 2(NaI/NaOH) , / . . 1(MnCl2) 2(NaI/NaOH) . .

7.5.3

(Niskin bottle) (Tygon tube) . . Tygon tube . . .

7.5.4

0.1 oC . mol L-1 mol kg-1 . .

7.5.5

300g 0.001g .

7.6

7.6.1

, , .

7.6.2

1 ml, 2 ml, 5 ml .
.(; Metrohm 665 Dosimat burette, SCHOTT Instruments TITRONIC universal)

7.6.3

(KIO3) 1.0 ml 10.0 ml . SOCOREX Calibrex 520 bottle-top . 1-11 ml 0.25 ml .
±0.002-0.005 ml . MetrohmTM .

7.6.4

25mm .

7.6.5

250 ml .

7.7

(5.1), (5.2), (5.3), (5.4), (5.5). (5.6) .

7.7.1 3M ($MnCl_2 \cdot 4H_2O$)

($MnCl_2 \cdot 4H_2O$) 600 g 500-700 ml 1000 mL . .
. (,) . ($MnSO_4 \cdot 4H_2O$) 480 g 1000 ml .

7.7.2 (NaI/NaOH)

(NaOH) 320 g 500 ml . .
(NaI) 600 g . (NaN_3) 10 g . 1000 ml .
. (,) .

7.7.3 50% (v/v) (H_2SO_4)

(H_2SO_4) 50 mL 1:1 (50 ml 50 ml) .
50 ml . 100 mL . (,) .
, .

7.7.4 1%

1 g 50 mL 100 mL .
. 1 , (Hg_2I_2) .

7.7.5 0.025 N ($Na_2S_2O_3 \cdot 5H_2O$)

($Na_2S_2O_3 \cdot 5H_2O$) 6.205 g 1000 mL .
. . 400 mol kg-1
2 ml .

$$4 \times (C_1 \times V_1) = C_2 \times V_2$$

,
$C_1 : [O_2] = 400 \mu mol L^{-1}$
$V_1 :$ (10%) $= 14ml$
$C_2 : [Na_2S_2O_3]$
$V_1 :$ (2ml)
4:1 (O_2) 4 $Na_2S_2O_3$
,
$[Na_2S_2O_3] = \frac{400\mu mol\ L^{-1} \times 140ml \times 4}{2ml} \simeq 0.11M$
$[Na\ 2\ S\ 2\ O\ 3\ ] = 400 * 10^-6 * 140 * 4 / Burettevolume(2ml) = 0.11M$

($Na_2S_2O_3 \cdot 5H_2O$) 1 248.17 g 27.4 g 1000 ml .
(Na2S2O3) 1 158.09 g 17.4 g . 2-5
1L .

7.7.6 0.001667 M (KIO_3,0.0100 N)

(KIO_3) 0.5 g 120℃ 2 . 0.3567g 1000
mL . (tp) . .
0.3567g , .

$$M(\ ) = \frac{1L}{(214.0g)}$$

7.8

7.9

.
. .
, , , . CFCs, Helium,
Noble gases(aragon and zenon), O^{17}, Oxygen, and pCO_2 .

7.10

1. .
2. ( ) .
3. .
4. .
   . 45 .
   2-3 . .
5. . .
   CTD .
6. 1 ml 1 ml 90
   . .
   . NaI/NaOH .
7. . 2 ml .
8. .
9. .
   .
10. 30 . .
11. 1 30 2 .
   .

7.11

7.12

1. .
2. (KIO_3) 1 ml .
3. 50 % 1ml .
4. NaI/NaOH 1ml .
5. $MnCl_2$ 1 ml .
6.
7. . . (V1) .
   V1 V3 .
8. (KIO_3) 1 ml (V2) .

7.13 ( ) by Carpenter (1965) method

1. .
2. .
3. 10.0 ml (0.00167 M) .
4. 50% 1 ml .
5. (NaI/NaOH) 1 ml . (I^-) (IO_3^-) (I_3^-) ($IO_3^- + 8I^- + 6H^+ \rightarrow 3I_3^- + 3H_2O$).
6. 1 ml .
7.
8. . 1 ml . . ($I_3^- + 2S_2O_3^{2-} \rightarrow 3I^- + S_4O_6^{2-}$). ± 0.03 ml .
9. (IO_3^-) 1 ($S_2O_3^{2-}$) 6 . . 4 . 0.3% , ml l Vstd .

$$C_{Na_2S_2O_3 \cdot 5H_2O} = \frac{C_{KIO_3} \times 10.0 \times 6}{V_{Na_2S_2O_3 \cdot 5H_2O}}$$

$C_{Na_2S_2O_3 \cdot 5H_2O}$: $Na_2S_2O_3 \cdot 5H_2O$ (mole/L)
C_{KIO_3} : KIO_3 (mole/L)
$V_{Na_2S_2O_3 \cdot 5H_2O}$: $Na_2S_2O_3 \cdot 5H_2O$ (mL)

7.14 (Standard-curve)

1. (KIO_3) 2, 4, 6, 8, 10 ml 5 .
2. .

7.15

1. .
2. .
3. 50% 1 ml . 50% 1 ml . pH (I_2) . .
4. (t_L) .
5. . ml ul Vsam .
6. . .

7.16

7.17

I_2 .
$V_{blk} = V_1 - V_2$

V_{blk} = V_1-(V_2-(V_3-1)) = $2V_1$-V_2-V_3
V_1: KIO3 1 ml
V_2: KIO_3 1 ml
V_3: KIO_3 1 ml
V_{blk} ml .

7.18 KIO_3

KIO_3 (t_p) 20 ℃ KIO_3 .

$$M(KIO_3,\ 20^\circ\text{C}) = \frac{m(KIO_3)/(213.995g \cdot mol^{-1})}{V_s} \times \frac{0.998206}{\rho_w(t_p)}$$

$m(KIO_3) :$ KIO_3
$V_s : KIO_3$ (t_p)
$213.995g\ mol^{-1} : KIO_3\ 1$
$\rho_w(t_p) :$
$V_s = V_s[1 + \alpha_V(t_L - 20)]$
α_V(Pyrex): $9.75 \times 10^{-6}\ {}^\circ K^{-1}$

7.19

(tL) .

$$M(Na_2S_2O_3,\ t_L) = \frac{6000 \times V(KIO_3,\ t_L) \times M(KIO_3,\ t_L)}{V_{std} - V_{blk}}$$

,
$V(KIO_3,\ t_L) = V(KIO_3,\ 20^\circ\text{C}) \times (1 + 9.75 \times 10^{-6}(t_L - 20))$
$M(KIO_3,\ t_L) = M(KIO_3,\ 20^\circ\text{C}) \times \frac{\rho_W(t_L)}{0.998206}$
$6000 = \frac{6mol\ \ Na_2S_2O_3}{1mol\ \ KIO_3} \times \frac{1000\mu l}{1ml}$
V_{std}:KIO_3
V_{blk}: (reagent blank) ml 1 .

7.20

(+ O_2) .

$$n(O_2) = (V_{sam} - V_{blk}) \times M(Na_2S_2O_3,\ t_L) \times \frac{1L}{10^6\mu l} \times \frac{1mol\ O_2}{4mol\ Na_2S_2O_3}$$

$$C(O_2) = \frac{[n(O_2) - 7.6 \times 10^{-8}]}{m(sample)}$$

,
7.6×10^8 : $(MnCl_2 + NaI/NaOH)$ 2 ml (O_2)
$m(sample)$ (kg) .
$m(sample) = V(O_2\ ,\ 20°\mathrm{C}) \times [1 + 9.75 \times 10^{-6}(t_s - 20)] - 2 \times \rho(t_S),\ S)$
,
t_S
2
ρ_{SW}

7.21 / (QA/QC)

5 10 . 0.44 mol/L . 0.16 0.94 mol/L . . ±0.1 % , ±0.45 mol kg-1 . . . . 1.78 mol/L . . CTD . CTD .

7.22

Chapter 8

chlorophyll a

8.1

chlorophyll a, b, c . chlorophyll a
. (,) ( ) .

8.2

8.2.1

90 % 750, 665, 645, 630, 480nm chlorophyll a, b, c (total carotenoids) . chlorophyll a 0.02 g/L , 0.04 g/L . chlorophyll a 5 g/L ± 0.3 g/L, chlorophyll b 0.5 g/L ± 0.2 g/L .

8.2.2

chlorophyll 5~10 100~200mL chlorophyll a phaeo-pigment . chlorophyll a 5 g/L ± 10 % .

8.2.3

chlorophyll (exiting wavelength) 436nm, (emission wavelength) 670nm chlorophyll a phaeo-pigment . chlorophyll a 5 g/L ± 10 % .

8.3

chlorophyll a, b, c . 750nm
. .

8.4

(4.1), (4.2), (4.3), (15mL)(4.4), (4.5), (4.6), (4.7), (4.8) (4.9), filter holder(4.10) .

8.4.1

8.4.2

GF/F, 47mm .

8.4.3

a .

8.4.4

, . 15 mL .

8.4.5

.

8.4.6 (spectrophotometer)

480nm, 630nm, 645nm, 665nm, 750nm 1cm cell .

8.4.7 (Turner 10AU)

F4T4-BL , Wratten 47 B Corning CS 5-60 filter, Corning CS 2-64 filter .

8.4.8 (spectrofluorometer)

436nm (exciting wavelength), 670nm (emission wavelength) 1cm cell .

8.4.9

a 50mL .

8.4.10 filter holder

a 25mm filter holder .

8.5

a (5.1), (5.2), (5.3, 5.4), (5.5) .

8.5.1 90% (v/v)

1000mL 100mL 900mL . .

8.5.2 1%

($MgCO_3$) 1g 100mL .

8.5.3 1:1

50 mL 100mL .

8.5.4 0.5 N

(37%) 41mL 1000mL .

8.5.5 100 ppm

100mg ($C_{20}H_{10}O_4Na_2$, sodium fluorescein) 1L . 1mL 100mL .

8.5.6 (Reference Material, RM)

Sigma Aldrich, Fluka

8.6

, 0.3 mm 0.5 5,000 mL( ) . , 100 200 mL fiter holder (GF/F, 25mm) .

1 % . .

15mL .

((-196℃ -80℃) , -20℃).
80 .

8.7

8.7.1

7.1.1. Cell-to-Cell Blank : cell 90 % Reference cell cell Cell-to-Cell blank 750 nm, 665 nm, 645 nm, 630 nm, 480 nm E .

$$E_{665} = OD_{665} - OD_{750} E_{645} = OD_{645} - OD_{750} E_{630} = OD_{630} - OD_{750}$$

OD (optical density) .

7.1.2. Blank : 750 nm E . E , Blank . ±0.002 , Cell-to- Cell Balnk E .
Membrane . E
. Blank 750nm Cell-to-Cell Blank E (E_b) f Blank .
f = 1 (, 666, 645, 630nm)
f = 2 (, 510nm)
f = 3 (, 480nm)

, Blank Cell-to-Cell Blank Blank (f x Eb) . .

$$Total\,Blank = (Cell - to - CellBlank) + (f \times E_b)$$

7.1.3. 0 : 90 % 0 .

8.7.2

7.2.1. , .
1/2 (20mm-Hg) .
1% (3~5) ( ).
( ) , 25mm filter holder 100~200mL . 1/2 . 1% (3~5) ( ). 7.2.2. chlorophyll . 7.2.3.
90% 15mL( ) 10mL( ) 4℃ .
7.2.4. 10 (3,000~4,000 rpm) .
7.2.5.
7.2.5.1 : 1cm 750nm, 665nm, 645nm, 630nm, 480nm .
7.2.5.2 : (R_B). 5% 2 3 2 3 (R_A). .
7.2.5.3 : 436nm, 670nm . 1cm

(F_B). 0.5N 2~3 (F_A).
1~2 mL 1~2 .

8.7.3

7.4.1. : (g/L) .

$$Chlorophyll\ a, b, c(\mu g/L) = \frac{C_{a,b,c} \times v}{V} \times 1000$$

$Chlorophyll\ a, b, c$: a, b, c (g/L)
v : (mL)
V : (mL)
C_a : 11.6 E_{665} - 1.31 E_{645} - 0.14 E_{630}(a)
C_b : 20.7 E_{645} - 4.34 E_{665} - 4.42 E_{630}(b)
C_c : 55 E_{630} - 1.31 E_{665} - 0.14 E_{645}(c)

7.4.2. : .

7.4.3. : (g/L) .

$$Chlorophyll\ a(\mu g/L) = F_D \frac{r}{r-1}(R_B - R_A) \times 1000$$

$$Phaeo - pigment(\mu g/L) = F_D \frac{r}{r-1}(rR_A - R_B) \times 1000$$

F_D : door
r :
R_B :
R_A :

7.4.4. : .

$$Chlorophyll\ a(\mu g/L) = \frac{(F_B - F_A)v}{F_{ph}(R-1)V}$$

$$Phaeo - pigment(\mu g/L) = \frac{R(F_A - F_b)v}{F_{ph}(R-1)V}$$

R : F_{ch}/F_{ph} (F_{ch} F_{ph} chlorophyll a phaeo-pigment) chlorophyll a F_B/F_A
v : 90% (mL)
V : (mL)

8.7.4

7.5.1. chlorophyll a . chlorophyll a chlorophyll . . *Skeletonema costatum* *Skeletonema costatum* (chlorophyll) *Coccolithus huxleyii* *Peridinium trochoidium* chlorophyll source . , phaeo-pigment . "bloom" ( ) . , Sigma Aldrich, Fluka .

7.5.2. 50 mL 90% . door 3 50 (R_3). chlorophyll a , door 3 F_3 .

$$F_3 = \frac{C_a}{R_3}$$

chlorophyll a door 10 30 50 90 % . F_{10} F_{30} .

7.5.3. Door F_D 7.5.1 7.5.2. , . r phaeo-pigment R_B/R_A . 2.2 .

8.7.5

$\times 1$, (exciting wavelength) 436 nm, (emission wavelength) 670 nm ($C_{20}H_{10}O_4Na_2$, sodium fluorescein) 1 ppm 100 (0.5 ppm 436 nm, 515 nm 100).

8.8 / (QA/QC)

8.9

Chapter 9

9.1

(CO_2) (NDIR) . . (2013-230) , , . 99% 0.05 mgC/L(4.16 molC/L) . 5 mgC/L(462.2 M) ±0.08 mg C/L(6.66 M) .

9.2

. 680 NDIR . (High-Temperature Catalytic Oxidation, HTCO) , Shimadzu HTCO . .

9.3

NDIR .

9.4

(4.1), (4.2), (4.3) . 10% 3 .

9.4.1

1.1.1. Go-Flo Teflon Teflon Niskin . O-ring . monofilament nylon Kevlar lanyard .

1.1.2. 10ml 40ml . Polycarbonate .

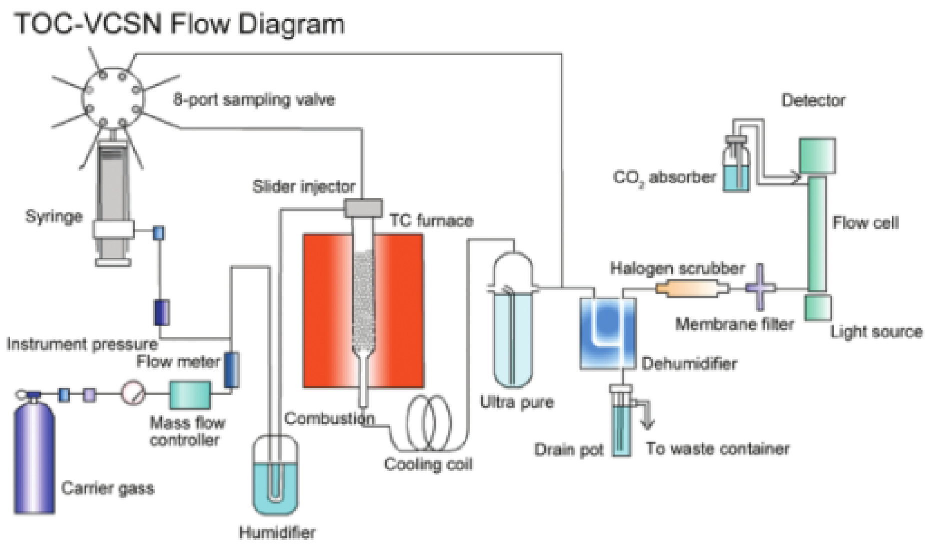


Figure 9.1:

1.1.3. .

9.4.2

PP, PE, Teflon 25/47mm 10%
. PP, PE, Teflon .

9.4.3

300g 0.001g .

9.4.4

1.4.1. 24mL vial*93 ea, 9ml vial*93 ea, 40mL*68 ea

1.4.2. 680

1.4.3.

1.4.4. (NDIR detector)

1.4.5. 250 ml .

9.5

(5.1), (5.2), (5.3), (5.4) .
10% 24 100 .

9.5.1 (Low-Carbon Water, LCW)

Milli-Q . . , , ,
.

9.5.2 (83.3 mmolC/L)

Potassium Hydrogen Phthalate(potassium biphthalate, $C_8H_5KO_4$, 204.22g/mol) 2.5g 100 4 . 2.1254g 700mL LCW 1000mL . LCW (4 l H_3PO_4/mL) pH 2~3 .

9.5.3 (Oxidation Effiency Check Stock Solution, OEC)

Sulfathiazole($C_9H_9N_3O_2S_2$, 255.31g/mol) 2.8g EDTA($C_{10}H_{16}N_2O_8$, 292.2438g/mol) 2.8g 100 4 .

1.1.1. _1(OEC_1) Sulfathiazole 2.3641g LCW 700mL 1000 mL (83.34 mmol C/L).

1.1.2. _2(OEC_2) EDTA 2.4354g LCW 700mL 1000 mL (88.33 mmol C/L).

1.1.3. (OEC_1, OEC_2) LCW . (4 l H_3PO_4/mL) pH 2~3).

9.5.4 (Carrier Gas)

(99.9995%) .

3

9.5.5

Niskin/Go-Flo 10% . Niskin . nylon, PP, Teflon phthalate . Niskin/Go-Flo . . .

9.5.6 ( )

PP, PE, Teflon 25/47mm 10% . PP, PE, Teflon . . (GF/F, 0.7 m) . GF/F 500 12 . . DOC 10% polycarbonate . Polycarbonate . 150 mmHg

. . .
laminar airflow workbench .

9.5.7

10 ml laminar flow workbench (ULTREX II, J.T.Baker; SUPRAPUR, Merck) (H3PO4) (HCl) (4 l H_3PO_4/mL sample, 12 l HCl/mL sample) pH=2~3 . . pH . pH 2 . . DOC Ziploc . DOC (Wiebinga and Barr, 1998). larminar flow workbench HDPE −20℃ 5 (Tupas et al., 1994). −20℃ . .

9.6

(5.2), (7.1), (7.2), (5.1) (7.3) .

9.6.1

3 10% 24 3 500 5 . Septum 10% 24 100 . Septum . 3 .

9.6.2

1.2.1. . Shimazu type 0.5% (Pt) (Al_2O_3) . . 0.5% 24 , LCW . 250ml (>2500) (Skoog et al., 1997). 1.2.2. 1 680 . 900 . 150 mL min^{-1} , , . Purge gas 50-75 mL min^{-1} . , , . Shimazu , , , , . , LCW . LCW 0.5 .

9.7 / (QA/QC)

9.7.1

10 7 3.14 (99%) .

9.7.2

, , .

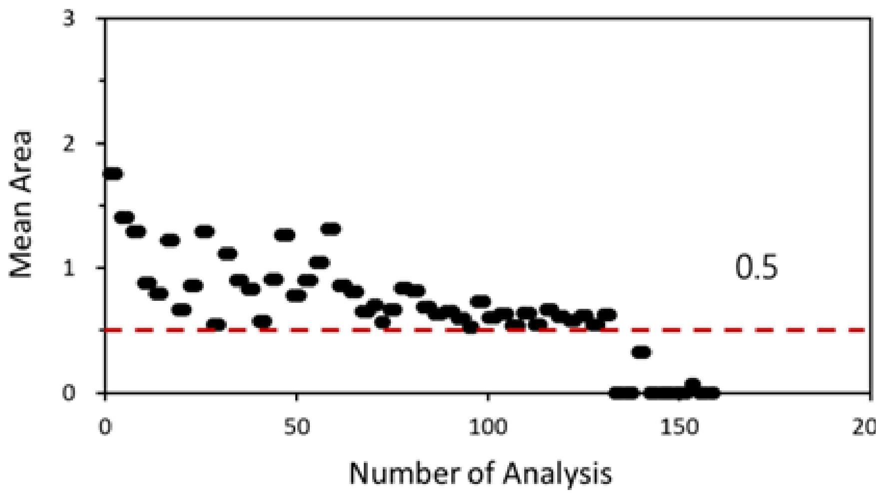


Figure 9.2: LCW (0.5)

9.7.3

laminar airflow workbench LCW (4 , 20) (2).

9.7.4

LCW . .

9.7.5

LCW Niskin ( ) . .

9.7.6

.

9.7.7

LCW . 1 . .

9.7.8 (Certified Reference Material, CRM)

Dr. Dennis Hansell (2 M C, 45 M C) . (10mL).

9.8

9.9

Turpas, L.M., Popp, B.N., Karl, D.M. (1994) Dissolved organic carbon in oligotrophic waters: experiments on sample preservation, storage and analysis. Mar.Chem. 45:207-216.

Wiebinga, C.J., de Baar, H.J.W. (1998) Determination of the distribution of dissolved organic carbon in the Indian sector of the Southern Ocean. Mar.Chem. 61:185-201.

Chapter 10

10.1

1kg (mol C kg^{-1}) . (1800~2300 mol kg^{-1}) (3800~4300 mol kg^{-1}) .

10.2

. . CO_2 CO_2 . pH 610nm . . .

$CO_2 + HO(CH_2)_2NH_2 \rightarrow HO(CH_2)_2NHCOO^- + H^+$
$H^+ + OH^- \rightarrow H_2O$

.

$H_2O + e^- \rightarrow \frac{1}{2}H_2(g) + OH^-$

.

$Ag(s) \rightarrow Ag^+ + e^-$

(Na_2CO_3) CO_2 .

10.3

1980 SOMMA (Single Operator Multi-parameter Metabolic Analyzer) 1990 . MRIANDA VINDTA 3C .

10.3.1

500mL glass-joint ( ) (CO_2) . VINDTA 3C(5420150413) , 8 9 19 mL . ±0.4℃ / .

10.3.2 CO_2

. CO2 (frit) . .

10.3.3

UIC (UIC CM5017O, 5420160221). . pH pK ±0.2℃ . . 100mL , 1℃ 200 . , .

10.3.4 PC

VINDTA 3C UIC CM5017O / VINDTA PC

10.4

(4.1), CO_2 (4.2), (4.3), (4.4), (4.5) .

10.4.1

CO_2 CO_2 (>99.999%). 10L , 4~5 .

10.4.2 CO_2

CO_2 CO_2 (Ascarite). .

10.4.3

. 85% 10 8.5% .

10.4.4

CO2 ( ) CO_2 . Peltier cooler 0~1℃ (condenser) ( ) (Supelco ORBO-53) CO_2 . H_2S , .

10.4.5

UIC 100 mL (, , (DMSO)). UIC 1 cm (, DMSO). .

10.5

( ) , , . CO_2 . 36 , 3 (, ,) . .

10.6

10.6.1

. 1) , 2) 2 “junk” , 3) , 4) CO_2 CRM , 5) TCT 24 . CO_2 CRM .

10.6.2

VINDTA “BLANK” . CO_2 10 10 1 . 25 , 25 . 25 VINDTA ‘blank’ 50 .

10.6.3

, ‘junk’ CO_2 CRM, . CO_2 . 20 mL , 1.5 mL . . .

10.6.4

. , (frit) . aqua regia . . 50℃ 12 . , .

10.7

10.7.1

(counts min^{-1}) .

$$b = \frac{N_b}{10}$$

, $N_b = 10$

10.7.2

.

$$C_T{}' = \frac{N_s - b \cdot t - a}{c} \cdot \frac{1}{V_s \cdot \rho}$$

$C_T{}'$ = (mol kg^{-1})
N_S = (counts)
a = (counts)
b = (counts min^{-1})
c = (counts mol^{-1})
t = (, min)
V_S = (mL, dm^3)
ρ = (g cm^{-3})

(headspace) CO_2
.

$$C_T = 1.0002(C_t{}' - \Delta C_T)$$

, ΔC_T CO_2 C_T . r 1% 0.5 mol kg^{-1} .

10.8 /

10.8.1

. CO_2 (1) 1.5 mol kg^{-1} ,
4 mol kg^{-1} . .
8.1.1. 25 counts min^{-1} (0.05 g C min^{-1}) , ±10 counts min^{-1}
. / .

($\bar{x}$) , .

(upper control limit) $UCL = \bar{x} + 3s$
(upper warning limit) $UWL = \bar{x} + 2s$
(lower warning limit) $LCL = \bar{x} - 2s$
(lower control limit) $LCL = \bar{x} - 3s$

8.1.2. CO_2 CRM
Scripps Dr. Dickson CO_2 CRM ( ). / .

8.1.3.
10 . / .

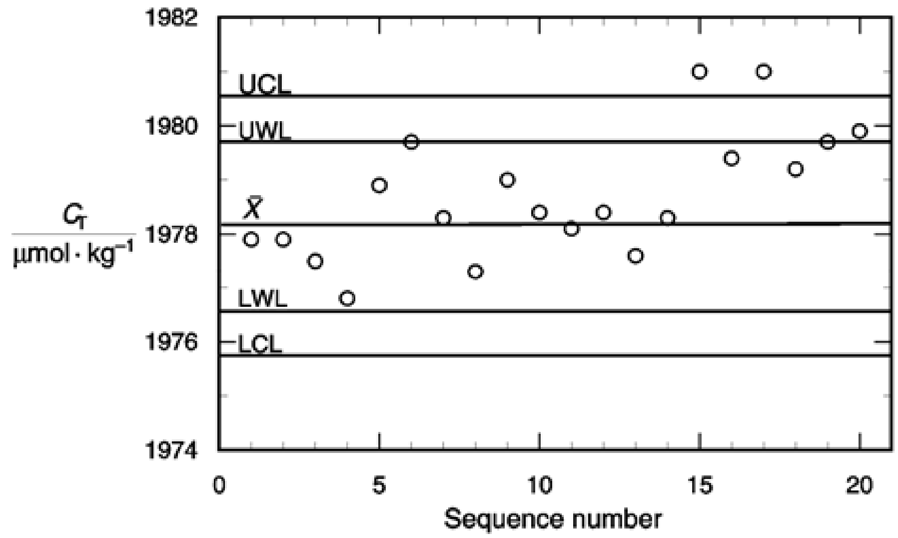


Figure 10.1:

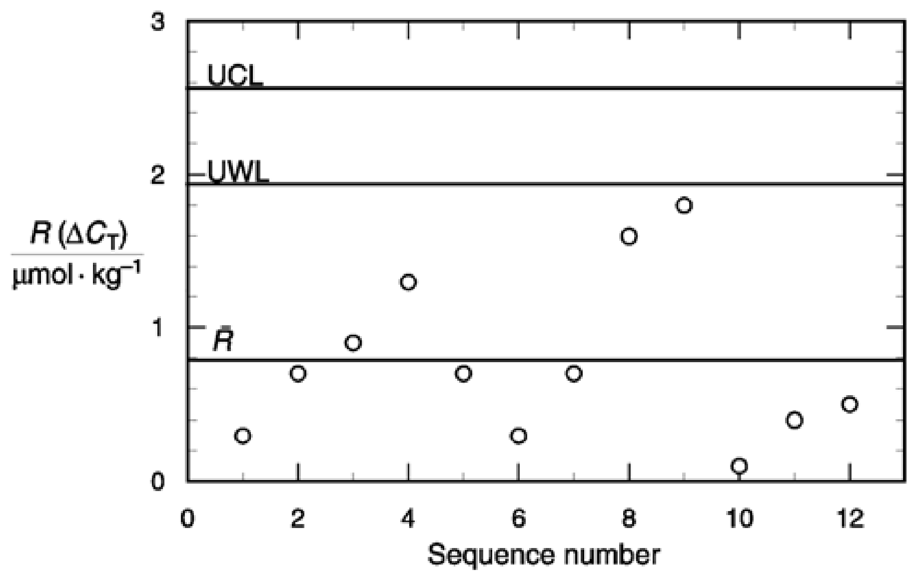


Figure 10.2:

(R) .

(upper control limit) $UCL = 3.267\bar{R}$
(upper warning limit) $UWL = 2.512\bar{R}$
(lower warning limit) $LCL = 0$
(lower control limit) $LCL = 0$

10.9

Dickson, A.G. 1992. The determination of total dissolved inorganic carbon in sea water. The first stage of a collaborative study. U.S. Department of Energy No.DOE/RL/01830T-H14.
Huffman, Jr., E.W.D. 1977. Performance of a new automatic carbon dioxide coulometer. Microchem. J. 22: 567–573.
Johnson, K.M., King, A.E. and Sieburth, J.M. 1985. Coulometric TCO2 analyses for marine studies; an introduction. Mar. Chem. 16: 61–82.
Johnson, K.M., Williams, P.J. leB., Brändström, L. and Sieburth, J.M. 1987. Coulometric TCO2 analysis for marine studies: automation and calibration. Mar.Chem. 21: 117–133.
Johnson, K.M., Wills, K.D., Butler, D.B., Johnson, W.K. and Wong, C.S. 1993. Coulometric total carbon dioxide analysis for marine studies: maximizing the performance of an automated continuous gas extraction system and coulometric detector. Mar. Chem. 44: 167–187.
UIC Inc. 1985. Instruction manual; model 5011 CO2 coulometer.
Wilke, R.J., Wallace, D.W.R. and Johnson, K.M. 1993. Water-based, gravimetric method for the determination of gas sample loop volume. Anal. Chem. 65: 2403–2406.